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Assessment of Antibiotic Consumption Patterns in Obstetric Inpatient Care: A Narrative Review

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ABSTRACT :

Background: Antimicrobial consumption surveillance in hospitals commonly uses defined daily doses (DDDs) per 100 bed-days. Although useful for general inpatient surveillance, this measure may be poorly aligned with obstetric care, where antibiotic exposure is frequently concentrated around delivery, prophylaxis may consist of a single administration, hospital stays are short and physiologically determined, and pregnancy produces pharmacokinetic changes that may separate prescribed doses from adult DDD values.

Objective: To assess how antibiotic consumption has been measured in obstetric inpatient care, examine the assumptions and limitations of DDD per 100 bed-days, consider lessons from paediatric and neonatal surveillance, and evaluate a delivery-anchored framework for reporting childbirth-associated antibiotic consumption.

Methods: A narrative review was conducted using purposive searches of PubMed, Scopus and Google Scholar, supplemented by citation tracking. Literature relevant to antimicrobial-consumption measurement in obstetric and peripartum care, and methodological studies from paediatric and neonatal settings, was synthesized thematically. PRISMA 2020-informed reporting principles were used to present the literature identification and selection process transparently; the review was not conducted as a systematic review and no meta-analysis was performed.

Results: Published obstetric studies used heterogeneous measures and denominators, including prescriptions, patients, deliveries, procedures, bed-days and proportions exposed. Three recurring measurement concerns were identified: single-dose prophylaxis is represented within the DDD numerator without conveying dose timing or duration; the bed-day denominator is sensitive to short and variable length of stay; and adult DDD constructs may not fully reflect dosing and pharmacokinetic characteristics of pregnancy. Paediatric and neonatal literature demonstrates that alternative measures, including days of therapy and population-specific DDD approaches, are feasible. A delivery-anchored framework using DDD per 100 deliveries, doses per delivery and days of therapy per 100 deliveries is proposed.

Conclusion: Assessment of antibiotic consumption in obstetric care would benefit from reporting that reflects the delivery episode as well as antibiotic amount and duration. DDD per 100 deliveries may be a useful candidate measure for childbirth-associated exposure, but it should initially complement rather than replace DDD per 100 bed-days. Multicentre validation, stratification by mode of delivery and separation of prophylaxis from treatment are needed before routine adoption.

Keywords: antibiotic consumption; obstetric care; antimicrobial stewardship; defined daily dose; days of therapy; caesarean section

Introduction

Surveillance of antimicrobial consumption is an important component of the global response to antimicrobial resistance. Hospital surveillance commonly expresses antibiotic use as defined daily doses (DDDs) per 100 bed-days, a standardized measure intended to facilitate comparisons across institutions and populations [1–3]. Its strength is comparability; however, a measure designed for broad adult inpatient surveillance may not adequately represent settings in which antibiotic exposure is concentrated around a defined clinical event.

Obstetric inpatient care represents such a setting. Antibiotic use around childbirth is often driven by guideline-supported prophylaxis, particularly for caesarean delivery, rather than by prolonged treatment of infection [4, 5]. Exposure may therefore occur as a single dose or a short course during a relatively brief admission. Length of stay after childbirth is influenced by physiological recovery and delivery mode rather than simply by the duration

of infection-related risk [18]. These features create a potential mismatch between delivery-centred antibiotic exposure and a time-based bed-day denominator.

A second concern relates to the DDD numerator. The DDD is an adult population-based technical unit and does not necessarily represent the prescribed dose for an individual patient or patient group [6, 7]. Pregnancy is associated with physiological changes that can alter drug distribution, renal clearance and other pharmacokinetic parameters [23, 24]. Consequently, the relationship between the dose administered to an obstetric patient and the assigned adult DDD may differ from that observed in the general adult inpatient population.

These issues matter because antibiotic-consumption metrics are used to describe prescribing patterns, compare services and support antimicrobial stewardship. If the denominator is strongly influenced by length of stay or the numerator does not distinguish single-dose prophylaxis from prolonged treatment, the resulting value can be difficult to interpret clinically. Previous work in paediatric and neonatal care illustrates that alternative measures, including days of therapy and population-specific DDD approaches, can be developed when conventional adult measures are poorly suited to the population [29–43].

This narrative review therefore assesses antibiotic-consumption measurement in obstetric inpatient care, examines the assumptions and limitations of DDD per 100 bed-days, reviews current reporting practices, considers lessons from paediatric and neonatal measurement, and presents a delivery-anchored framework for more clinically interpretable reporting.

Methods

2.1 Review design

This study was conducted as a narrative review to critically examine how antibiotic consumption has been measured in obstetric inpatient and peripartum care. The review focused on methodological issues surrounding DDD-based surveillance and on complementary measures that may better describe exposure associated with childbirth.

2.2 Literature search and sources

PubMed, Scopus and Google Scholar were searched using combinations of terms related to antibiotic consumption, antimicrobial use, defined daily dose, days of therapy, obstetrics, pregnancy, childbirth, caesarean section, prophylaxis and antimicrobial stewardship. Reference lists of relevant publications were screened for additional sources. Literature was selected for relevance to antimicrobial-consumption measurement in obstetric, peripartum, paediatric or neonatal inpatient populations and to the methodological interpretation of ATC/DDD-based measures.

Because this was a narrative review, no formal protocol was registered, no quantitative synthesis was undertaken and no formal risk-of-bias assessment was performed. The literature was synthesised thematically to examine the assumptions of DDD per 100 bed-days, identify obstetric-specific measurement problems, assess analogous solutions in paediatric and neonatal care, and develop the proposed episode-anchored reporting framework.

2.3 Eligibility criteria

Publications were considered eligible when they addressed antibiotic or antimicrobial consumption measurement in obstetric or peripartum care, or provided directly relevant methodological evidence from paediatric or neonatal populations. Studies reporting consumption measures, denominators, dosing measures, days of therapy or methodological comparisons were considered relevant. Publications unrelated to the review question, without relevant consumption-measurement information, or without sufficient methodological detail were excluded.

2.4 Study selection

The literature identification and selection process was reported using PRISMA 2020-informed flow reporting [61] to improve transparency. Titles and abstracts were screened for relevance followed by assessment of eligible full-text reports. The selection process was descriptive and is intended to document the pathway used for this narrative synthesis rather than to imply a systematic-review methodology.

2.5 Data extraction and synthesis

Information extracted from relevant publications included study setting, population, measurement method, denominator, principal methodological findings and relevance to obstetric antimicrobial-consumption surveillance. Findings were synthesized narratively under four themes: limitations of conventional DDD per 100 bed-days; lessons from paediatric and neonatal measurement; current reporting in obstetric care; and development of a delivery-anchored framework.

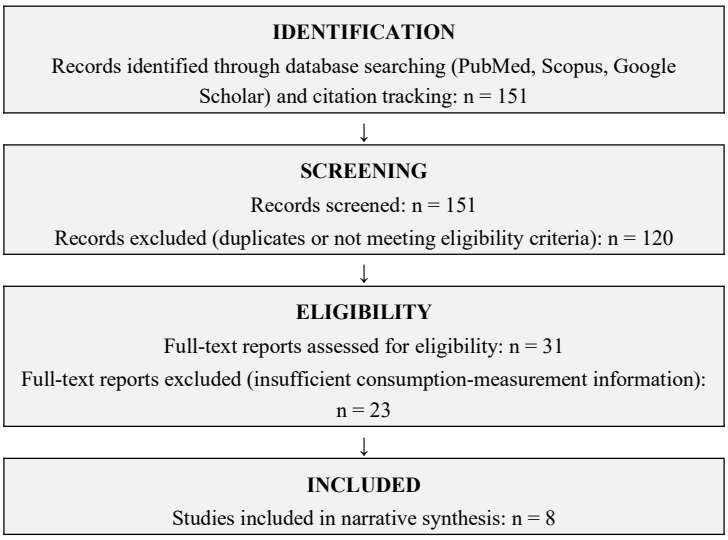
2.6 Ethical considerations

No human participants, identifiable patient data or human tissue were involved. Ethical committee approval was therefore not required.

Results

3.1 Literature identification and selection

The literature search identified 151 records. Following title and abstract screening, 120 records were excluded because they were duplicates or did not meet the predefined eligibility criteria. Thirty-one full-text reports were assessed for eligibility. Twenty-three reports were excluded because they did not provide sufficiently relevant consumption-measurement information for the review question. Eight studies were included in the narrative synthesis (Fig. 1).



PRISMA 2020-informed reporting used for transparency; this manuscript remains a narrative review.

Fig. 1 - PRISMA 2020-informed flow diagram of literature identification, screening, eligibility assessment and inclusion.

3.2 The ATC/DDD system and its underlying assumptions

The DDD is defined by the WHO Collaborating Centre for Drug Statistics Methodology as "the assumed average maintenance dose per day for a drug used for its main indication in adults." [6] The Centre is unusually explicit that this is a technical construct rather than a clinical recommendation: the DDD "is a unit of measurement and does not necessarily reflect the recommended or Prescribed Daily Dose," and "therapeutic doses for individual patients and patient groups will often differ from the DDD as they will be based on individual characteristics (such as age, weight, ethnic differences, type and severity of disease) and pharmacokinetic considerations." [7] Consumption data expressed in DDDs, the Centre states, "only give a rough estimate of consumption and not an exact picture of actual use." [7]

The bed-day denominator has a separate and more specific origin. Hekster and colleagues proposed DDD per 100 bed-days in 1982 as a unit of comparison for studying antimicrobial use in a university hospital, in the context of auditing the effect of prescribing guidelines [8]. The denominator was constructed for a general adult inpatient population in which admission duration approximates time at risk of receiving antibiotics. It has never been formally validated for populations in which that correspondence fails.

Three assumptions are therefore embedded in the composite metric.

Assumption 1 — the numerator assumption. A drug is administered as a multi-day course at approximately the adult maintenance dose, so that total grams consumed divided by the DDD approximates the number of treatment days delivered.

Assumption 2 — the denominator assumption. Bed-days are a reasonable proxy for time at risk of antibiotic exposure, so that a ward with twice the bed-days will, all else equal, generate twice the antibiotic consumption.

Assumption 3 — the population assumption. Patients approximate the standard adult for whom DDDs are assigned, so that prescribed doses cluster near the DDD.

On a general adult medical ward these hold well enough. In obstetric inpatient care each fails, and each fails in the same direction.

3.3 Why standard DDD per 100 bed-days may misrepresent obstetric antibiotic consumption

3.3.1 The single-dose problem

Antibiotic prophylaxis at caesarean section is a single dose administered before skin incision. WHO recommends prophylaxis for all caesarean sections, with administration prior to incision rather than after cord clamping [4]. Systematic review and meta-analysis have established that a single dose is not inferior to multiple-dose regimens for preventing postoperative infection [9], a finding confirmed by subsequent network meta-analysis across agents [10], and Cochrane evidence supports the pre-incision timing [11]. WHO's global guidelines for the prevention of surgical site infection reach the same conclusion for surgery generally: moderate-quality evidence shows that continuing prophylaxis postoperatively has neither benefit nor harm compared with a single dose [12].

A single dose is therefore the clinically correct exposure. The measurement problem is what the DDD system does with it.

The parenteral DDD for ceftriaxone is 2 g [13]. A single 2 g intrapartum dose consequently registers as one complete DDD — arithmetically identical to a patient receiving 2 g daily as treatment, and identical again to a full day of therapy on a medical ward. A 1 g dose, the strength most commonly used in practice, registers as 0.5 DDD. The metric records grams consumed; it is blind to whether those grams were delivered over five minutes or twenty-four hours.

The distortion is not uniform across agents, which makes it worse. Because DDDs are assigned per substance, the ratio between a single prophylactic dose and one DDD varies widely: a 1.5 g dose of metronidazole equals one parenteral DDD, a 2 g ampicillin dose equals one-third of the 6 g parenteral DDD, and a 4.5 g dose of piperacillin–tazobactam equals slightly under one-third of the 14 g DDD [13]. Two units administering an identical number of single prophylactic doses will therefore report substantially different DDD totals purely as a function of which agent they use. Rank ordering of agents by DDD in a prophylaxis-dominated setting reflects the DDD assignment as much as it reflects prescribing behaviour.

This specific point — that single-dose surgical prophylaxis distorts DDD-based consumption figures — does not appear to have been made explicitly in the literature. The components are well established: DDD is dose-insensitive [14], prescribed daily doses diverge from DDDs in a drug-specific manner [15, 16], and European point prevalence data show that surgical prophylaxis is a large and distinct component of hospital antibiotic use, with over half of surgical prophylaxis prescriptions continued beyond one day [17]. The synthesis, however, appears to be unmade, and we state it here as an inference from those components rather than as a cited finding.

3.3.2 The denominator problem

Postpartum admission is short and its duration is determined by physiological recovery, not by resolution of infection. In India, length of stay after childbirth differs systematically by delivery mode and by whether care is delivered in a public or private institution, and is measured in days rather than weeks [18].

This matters because the bed-day denominator was designed on the premise that admission duration tracks time at risk. In obstetric care it does not. A woman delivering vaginally who receives no antibiotics contributes bed-days to the denominator; a woman undergoing caesarean section receives her entire prophylactic exposure within minutes of admission to theatre and then contributes two or three further bed-days during which no antibiotic is given. Antibiotic exposure in obstetrics is concentrated at a point in the admission; the denominator accumulates uniformly across it.

The arithmetic consequence is that the reported rate becomes a function of length of stay. Consider two units administering identical prophylaxis — one 2 g ceftriaxone dose per caesarean, and nothing else — to 100 caesarean patients. Unit A discharges at three days and accumulates 300 bed-days, reporting 33.3 DDD per 100 bed-days. Unit B, with an enhanced recovery protocol, discharges at two days and accumulates 200 bed-days, reporting 50.0 DDD per 100 bed-days. Unit B appears to consume 50 per cent more antibiotic while having administered exactly the same drug to exactly the same number of women. The difference is entirely denominator artefact, and it is in the perverse direction: shortening length of stay, an unambiguous quality improvement, worsens the apparent stewardship performance.

This is not a purely theoretical concern. Moehring and colleagues, comparing days present with patient-days as denominators for antimicrobial use, found the discrepancy between them was greatest for stays of shorter duration [19]. Avedissian and colleagues quantified how substantially standardised consumption rates move when only the denominator definition changes [20]. Čižman and Beović argued directly that DDD per 100 bed-days is confounded by case-mix and length of stay [21]. De With and colleagues, varying numerator and denominator within a single dataset, showed that the direction of the reported consumption trend could change depending on the combination chosen [22]. None of these analyses examined obstetrics specifically, and we are not aware of any study that has quantified the magnitude of the distortion in a maternity population — a gap that is itself worth addressing.

3.3.3 The population problem

DDDs are assigned for adults, and the WHO Collaborating Centre states plainly that "DDDs are normally assigned based on use in adults." [6] Pregnancy produces substantial and well-characterised departures from the non-pregnant adult: plasma volume and total body water expand, volume of

distribution increases, glomerular filtration rate and renal clearance rise, and protein binding is altered [23]. For renally cleared antibiotics these changes are clinically material.

The evidence is specific rather than general. Popović and colleagues measured the pharmacokinetics of ceftriaxone, cefazolin and gentamicin in women undergoing caesarean section against non-pregnant controls and demonstrated altered disposition in the pregnant group [24]. These are precisely the agents that dominate obstetric prescribing. Where altered pharmacokinetics prompt clinicians to use higher doses or shorter dosing intervals than the DDD assumes, the divergence between prescribed daily dose and DDD widens — a divergence already documented across agents and settings [15, 16, 25, 26], and shown by Grimmsmann and Himmel to depend on the patient population as well as the drug class [27]. Haug and Reikvam demonstrated that adjusting DDDs to locally prescribed doses materially changes surveillance conclusions [28].

The obstetric population is therefore a physiologically distinct adult population being measured with a metric whose reference construct is based on standard adult use.

3.4 Lessons from paediatric and neonatal antimicrobial-use measurement

Obstetrics is not the first specialty to find that the DDD does not fit. The paediatric and neonatal experience is directly instructive, and it is the strongest argument that this problem is soluble rather than merely regrettable.

The WHO Collaborating Centre itself concedes the limitation for children, stating that "paediatric DDDs are challenging to assign and problems related to drug utilization research in children cannot be solved by such means." [6] Fortin and colleagues, in a systematic review of measures applicable to paediatrics, established that adult DDD-based measures are not valid in children and that alternatives are required [29]. Jasso-Gutiérrez and Santos-Preciado made the narrower point that DDD per 100 bed-days specifically is unsuitable in a paediatric hospital [30]. Schulman and Saiman asked, in a short methodological commentary directly analogous to the present argument, which rate is the right rate for neonatal intensive care [31].

Two distinct responses followed, and both remain live.

The first was replacement. North American paediatric practice moved substantially to days of therapy per 1,000 patient-days. Polk and colleagues had already shown that DDD and days of therapy rank hospitals and agents differently in adults [14]; Gerber and colleagues then benchmarked variability across children's hospitals entirely in days of therapy [32], and Dalton and colleagues demonstrated four years of paediatric surveillance conducted on that basis [33]. Porta and colleagues developed an explicit algorithm for international paediatric benchmarking in recognition that DDD per 100 bed-days was unfit for the purpose [34].

The second was recalibration. Rather than abandon the DDD, several groups constructed population-specific values. Liem and colleagues proposed neonatal DDDs as early as 2010 [35]. Montecatine-Alonso and colleagues developed weight-adjusted DDDs for children [36], then a full paediatric DDD set [37], with a neonatal derivation [38] subsequently validated in clinical practice [39] and applied in recent neonatal monitoring [40]. Rachina and colleagues compared conventional and paediatric-adjusted methodologies head to head in mixed hospitals and quantified how much the answer changes [41].

The debate is not settled, and an honest account must say so. Castagnola and colleagues argue from single-centre data that a paediatric-specific DDD may not be necessary at all [42]. Multinational consensus recommendations for paediatric antimicrobial stewardship now exist and address measurement explicitly [43]. Prevalence-based quality indicators offer a third route entirely, as developed in the ARPEC point prevalence survey [44] and applied at scale in AWaRe-based paediatric analyses [45].

We did not identify an obstetric-adjusted DDD set or a comparable obstetric consensus statement on consumption measurement in the literature located by our purposive search. Only one study appears to have compared DDD and days of therapy in an obstetrics and gynaecology population at all — Guillot and colleagues, in a comparative analysis of antifungal agents across paediatrics and obstetrics-gynaecology [46]. That single paper is the entirety of the prior art.

3.5 Current reporting of antibiotic consumption in obstetric care

To characterise current practice we examined published studies reporting antibiotic use in obstetric or peripartum inpatients. The pattern is one of methodological heterogeneity severe enough to preclude any pooling or benchmarking. (Table 1).

Hodoşan and colleagues reported perinatal antibiotic consumption in a Romanian public university hospital using DDD methodology, and remains the principal obstetric DDD reference [47]. Sharma and colleagues studied antibiotic prescribing during and after delivery in an Indian tertiary hospital, reporting prescription-level rather than consumption-level data [48]. Yan and colleagues examined prescribing in connection with childbirth in Lao PDR using the birth episode as the unit of analysis [49]. Saleem and colleagues, reporting intrapartum and postpartum antibiotic use across seven low- and middle-income countries within the A-PLUS trial, likewise anchored their analysis to the delivery [50]. Gardemeister and colleagues reported the proportion of full-term deliveries in Finland in which antibiotics were used during childbirth [51]. Abubakar and colleagues described surgical antibiotic prophylaxis utilisation for obstetric and gynaecological surgery in Northern Nigeria [52], and Islam and colleagues reported antimicrobial use

trends in an obstetrics and gynaecology department in Bangladesh [53]. At population level, Orwa and colleagues pooled the global prevalence of antibiotic consumption during pregnancy [54].

Three observations follow.

First, the denominator is not shared. Studies variously report per prescription, per patient, per delivery, per bed-day, or as a simple proportion exposed. No two of the studies above are directly comparable on consumption.

Second, DDD-based reporting is the exception rather than the rule in obstetrics, and where it is used the bed-day denominator carries all the problems described above.

Third — and most usefully — the studies that anchor to the delivery episode do so without difficulty. Gardemeister and colleagues report exposure per delivery [51], and the A-PLUS analysis treats the delivery as the natural unit [50]. The denominator we propose is therefore not a novel construct requiring new data collection; it is a formalisation of what several investigators have already found to be the intuitive unit in this setting.

Table 1 - Comparison of candidate antibiotic consumption metrics in obstetric care.

Metric	Primary information	Main limitation in obstetric care
DDD per 100 bed-days	Quantity normalised to inpatient time	Sensitive to short and variable length of stay.
DDD per 100 deliveries	Quantity normalised to delivery episodes	Retains limitations of the DDD numerator.
Doses per delivery	Frequency/breadth of administration	Does not capture dose magnitude.
Days of therapy per 100 deliveries	Duration of exposure	Does not quantify total antibiotic amount.
Proportion of deliveries exposed	Population reach of antibiotic use	Does not capture amount or duration.

3.6 Proposed delivery-anchored framework

We propose DDD per 100 deliveries as a candidate episode-anchored metric for antibiotic consumption associated with childbirth:

$$\textit{DDD per 100 deliveries} = (\textit{Total grams of antibiotic consumed} \div \textit{WHO DDD for that agent}) \div (\textit{Number of deliveries}) \times 100 \quad (1)$$

Deliveries, not admissions, are the denominator for childbirth-associated exposure. Where a unit admits obstetric patients who do not deliver — for antenatal complications, for example — those admissions and their antibiotic consumption should be reported separately rather than folded into the delivery denominator.

Why the delivery is the right unit

For childbirth-associated exposure, the delivery is the most clinically intuitive care episode. Peripartum antibiotic exposure is triggered by, and proportionate to, the delivery event rather than to time in bed. Anchoring the denominator to the event aligns the measure with the thing that generates the exposure.

It is countable and universally recorded. Every maternity unit knows its delivery count, by mode, without additional data collection. This is not true of bed-days in many low-resource settings, where occupancy data are often estimated.

It is insensitive to length of stay. Returning to the earlier worked example, both units administering one 2 g ceftriaxone dose to each of 100 caesarean patients report 100 DDD per 100 deliveries irrespective of whether they discharge at two days or three. The metric no longer penalises shorter stays.

It permits meaningful stratification. Reporting separately for vaginal delivery, elective caesarean and emergency caesarean produces three clinically interpretable figures, because each corresponds to a different guideline-defined prophylactic expectation.

It has precedent. Episode-anchored denominators are not new: DDD per 100 discharges has been compared directly with DDD per 100 bed-days both after implementation of a stewardship programme [55] and in a recent multi-year analysis in Costa Rican tertiary hospitals [56]. Days present, admissions and discharges have all been examined as alternatives to patient-days [19, 20, 57]. The proposal here is to select, for one specialty, the episode denominator that corresponds to its actual clinical unit.

What it does not fix

Candour about the limits matters more than advocacy. DDD per 100 deliveries corrects the denominator problem. It does not correct the single-dose problem, because that defect lives in the numerator. A single 2 g ceftriaxone dose still counts as one DDD.

Two remedies are available and we recommend the first. Report a dose-count metric alongside. Doses per delivery, and days of therapy per 100 deliveries, are trivially derived from the same data and directly expose what the DDD conceals: whether a unit's consumption reflects many patients receiving one dose each, or fewer patients receiving prolonged courses. These are radically different stewardship problems that DDD alone cannot

distinguish. The second remedy — constructing obstetric-specific DDDs on the paediatric model [37, 38] — is more demanding and, we would argue, less useful, since the problem in obstetrics is dose count rather than dose size.

Nor does the metric resolve attribution where maternal antibiotics are given wholly or partly for neonatal benefit, as in intrapartum prophylaxis against group B streptococcal disease. That exposure appears in the maternal denominator while its intended beneficiary is the neonate. We note the issue without resolving it.

Finally, the proposal is untested. It is a reasoned argument from the properties of the setting, not a validated instrument, and the validation required is set out below.

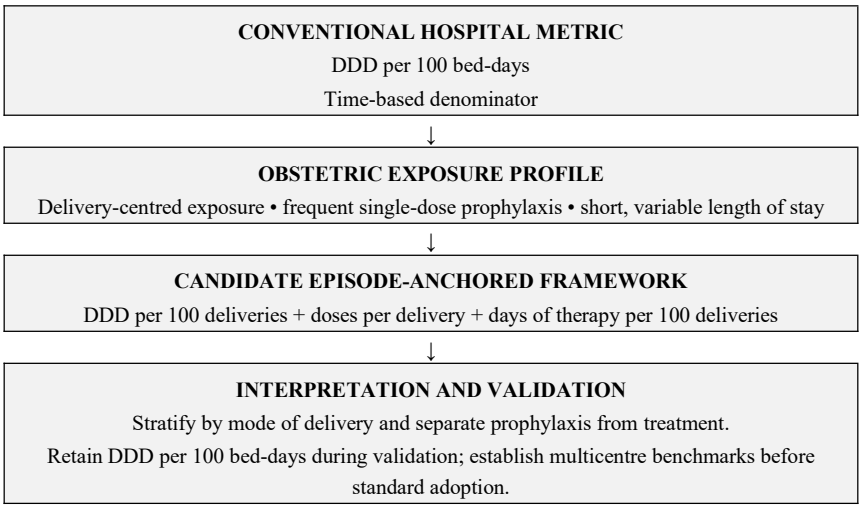


Fig. 2 - Conceptual framework for measuring antibiotic consumption in obstetric inpatient care.

3.7 Proposed minimum reporting standard

Whichever primary metric is adopted, comparability requires that obstetric antibiotic consumption studies report a common minimum dataset. We propose the following. (Table 2).

1. DDD per 100 deliveries as the primary consumption measure, with the delivery count stated.
2. DDD per 100 bed-days reported alongside, for backward comparability with the existing literature, with mean length of stay stated so that readers can reconstruct either figure.
3. Doses per delivery and days of therapy per 100 deliveries, to separate breadth of exposure from duration.
4. Stratification by mode of delivery — vaginal, elective caesarean, emergency caesarean — since prophylactic expectations differ by guideline for each.
5. Separation of prophylaxis from treatment. Aggregating a single pre-incision dose with a five-day course for endometritis produces a number that describes neither.
6. AWaRe composition, reported as the proportion of consumption in the Access, Watch and Reserve groups [58, 59], with the AWaRe version stated, since the classification was revised in 2025 [60].
7. The ATC/DDD Index year used, since DDD values are periodically revised and consumption figures are not comparable across index versions [6].

Points 6 and 7 are not incidental. Reporting an AWaRe breakdown without naming the version, or a DDD figure without naming the index year, renders the result uninterpretable a few years later.

Table 2 - Proposed minimum reporting standard for antibiotic consumption in obstetric inpatient care.

Element	Requirement	Rationale
Primary metric	DDD per 100 deliveries, with delivery count stated	Anchors exposure to the care episode that generates it.
Secondary metric	DDD per 100 bed-days, with mean length of stay stated	Preserves comparability with existing literature.
Exposure breadth	Doses per delivery	Distinguishes many single doses from few long courses.

Element	Requirement	Rationale
Exposure duration	Days of therapy per 100 deliveries	Captures duration, which DDD conceals.
Stratification	Vaginal, elective caesarean, emergency caesarean	Prophylactic expectations differ by mode.
Indication	Prophylaxis reported separately from treatment	Aggregation renders both uninterpretable.
Spectrum	AWaRe Access/Watch/Reserve proportions; version stated	Provides stewardship context.
Provenance	ATC/DDD Index year stated	DDD values are periodically revised.

Discussion

The evidence synthesized in this review indicates that the principal challenge in obstetric antibiotic-consumption surveillance is not a lack of measurement methods, but a mismatch between the clinical pattern of exposure and the assumptions embedded in commonly used metrics. DDD per 100 bed-days remains useful for broad hospital comparison, yet obstetric care frequently concentrates antibiotic exposure around childbirth while inpatient time extends beyond the period of active antibiotic administration. The resulting value may therefore reflect length of stay as well as antibiotic use.

The single-dose prophylaxis problem is particularly important. A single prophylactic administration can register as a substantial fraction or an entire DDD depending on the agent, even though the exposure may last only minutes. Consequently, DDD values alone cannot distinguish a large number of appropriately administered single prophylactic doses from prolonged therapeutic courses. The reviewed literature on discrepancies between DDDs and prescribed or administered doses supports cautious interpretation of such measures [14–17, 25–28].

The denominator problem is complementary. Short and variable postpartum admissions can alter DDD per 100 bed-days without any change in the amount of antibiotic administered. Evidence from studies comparing denominators in hospital antimicrobial surveillance demonstrates that estimates can change materially when only the denominator definition changes, particularly for short stays [19–22]. This supports the use of an episode-based denominator when the clinical event generating exposure is identifiable.

The population issue further complicates interpretation. WHO DDDs are constructed around adult use, whereas pregnancy produces well-characterized physiological changes in volume of distribution, renal function and protein binding [23, 24]. Differences between prescribed daily doses and DDDs are well documented across drugs and patient populations [15, 16, 25–28]. The implication is not that DDDs should be abandoned, but that their use in obstetric populations should be supplemented by measures that describe actual exposure more directly.

Paediatric and neonatal experience provides an important methodological precedent. Adult DDD measures have long been questioned in children, leading to the adoption of days-of-therapy measures, population-specific DDDs and prevalence-based indicators in different settings [29–45]. Obstetrics has different clinical characteristics, but the underlying lesson is similar: measurement should be aligned with the population and clinical episode being studied.

The proposed delivery-anchored framework responds primarily to the denominator problem. DDD per 100 deliveries links consumption to the event that generates childbirth-associated exposure and is less sensitive to variation in length of stay. It does not, however, solve the numerator limitations of DDD. For this reason, doses per delivery and days of therapy per 100 deliveries should accompany the DDD measure. Stratification by vaginal delivery, elective caesarean and emergency caesarean, together with separation of prophylaxis from treatment, would further improve interpretability.

The framework should be regarded as a candidate reporting approach rather than a validated replacement for current hospital surveillance. The literature reviewed did not establish a consensus obstetric-adjusted DDD system or a validated benchmark for DDD per 100 deliveries. The most useful next steps are therefore multicentre comparisons of DDD per 100 deliveries with DDD per 100 bed-days, days of therapy and exposure prevalence; establishment of benchmark ranges; and consensus development around a minimum reporting dataset.

4.1 Research priorities for validation

Four studies would move this from argument to evidence.

Quantify the distortion. In a maternity dataset with individual-level dispensing and length-of-stay data, calculate consumption under both denominators and report the magnitude and direction of the difference, stratified by mode of delivery. This is a straightforward secondary analysis of data many units already hold.

Establish benchmark ranges. A multi-centre study reporting DDD per 100 deliveries across facilities of differing type and country income group would create, for the first time, a range against which any single unit could be interpreted.

Test agreement between metrics. Following the design of Polk and colleagues [14], determine whether DDD per 100 deliveries, DDD per 100 bed-days and days of therapy rank obstetric units concordantly. If they do not, the choice of metric is a substantive finding, not a technicality.

Develop consensus. A multinational consensus process on obstetric antimicrobial consumption metrics, on the model of the paediatric recommendations [43], would give the field a shared standard. Its absence is conspicuous.

4.2 Limitations and critical appraisal

This is a narrative rather than a systematic review. Studies were identified through purposive searching of PubMed, Scopus and Google Scholar and by citation tracking; no formal protocol was registered, no systematic screening was undertaken, and the study set in Table 1 should be read as illustrative of current reporting practice rather than exhaustive. Obstetric consumption studies published in journals not indexed in the databases searched, and those published in languages other than English, may be under-represented.

The central proposal is untested. We have argued from the structural properties of obstetric care and from precedent in an analogous specialty, but DDD per 100 deliveries has not been validated against any reference standard, and its behaviour across facilities of differing case-mix is unknown. Two of the arguments advanced — that single-dose prophylaxis distorts DDD-based figures, and that obstetric length of stay distorts the bed-day denominator — are inferences from established components rather than directly evidenced findings, and are labelled as such in the text.

Because the proposed framework is derived from a narrative synthesis, the findings should be interpreted as methodological reasoning supported by published evidence rather than as a validated instrument or benchmark.

Conclusion

DDD per 100 bed-days is a useful general hospital consumption measure, but its assumptions may be poorly aligned with the distinctive exposure patterns and short lengths of stay characteristic of obstetric inpatient care. A delivery-based denominator may provide a more clinically intuitive basis for reporting childbirth-associated antibiotic consumption because it is anchored to the care episode rather than inpatient time. We therefore propose DDD per 100 deliveries as a candidate episode-anchored metric, supplemented by doses per delivery and days of therapy per 100 deliveries, with stratification by mode of delivery and separation of prophylaxis from treatment. The metric should not yet be regarded as a validated replacement for established hospital measures. Multicentre studies comparing DDD per 100 deliveries with DDD per 100 bed-days, days of therapy and exposure prevalence are needed to determine its validity, reproducibility, sensitivity to case-mix and usefulness for benchmarking.

Neonatology met the same problem and resolved it, by recalibrating the metric in some settings and replacing it in others. A comparable standardised measurement approach has not yet been established in obstetric care. Adopting the delivery as the denominator is a modest change requiring no new data collection, and it aligns the measure with the event that actually generates the exposure. Paired with a dose-count metric and a minimum reporting standard, if validated, it could facilitate more clinically interpretable comparison of antibiotic consumption across obstetric units and support future stewardship benchmarking.

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Declarations

Ethical clearance: Not applicable. This review analyses previously published literature and involved no human participants, human data or human tissue.

Data availability: No new data were generated; all sources are published and cited.

Conflict of interest: The authors declare no conflict of interest.

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