RESEARCH PAPER

Antibiotic Stewardship Programs Across Surgery, Internal Medicine, and General Practice A Systematic Review of Outcomes and Resistance Rates

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Abstract

Background

ASPs are complex and scientifically validated processes that aim to optimize antibiotic utilization, minimize drug-related complications, slow down the evolution and transmission of antibiotic resistance, and lower healthcare expenditures. Although widely adopted in hospitals and communities, ASP initiatives vary greatly in terms of structure, performance metrics, and the areas of clinical practice being evaluated. Prescribing in surgical wards, internal medicine units, and general practice requires different approaches, and whether ASP strategies transfer equivalently to each setting is unclear.

Objectives

The objective of this systematic review is to summarize current research between 2020 and 2026 concerning ASPs conducted in surgeries, internal medicine, and general practice with regard to antibiotic use, resistance rates, clinical endpoints (mortality, length of stay, re-admissions), and cost-effectiveness.

Methods

We searched PubMed/MEDLINE, EMBASE, CINAHL, and Cochrane Library databases for peer-reviewed articles published from January 2020 to December 2025 that evaluated the impact of an ASP intervention in a formalized setting, measured quantitative outcomes, and involved surgical, internal medicine, or general practice populations. The risk of bias was assessed based on the Cochrane RoB 2.0 instrument for randomized controlled trials and the Newcastle-Ottawa Scale for observational studies. Two independent reviewers performed the data extraction process; disputes were settled via consensus.

Results

Ten articles were included, which covered 48,316 patients from 14 countries. ASPs were linked to substantial decreases in total antibiotic utilization (11.4%–38.7%), reduction in the use of broad-spectrum antibiotics (-26.3%), and reduced CDI incidence (OR 0.61, 95% CI 0.47–0.79). In six out of ten articles, resistance rates for the ESKAPE pathogens significantly fell. Surgical ASPs proved the most effective in reducing overprescription of antibiotic prophylaxis. Programs aimed at internal medicine yielded the largest decreases in the incidence of CDI and MDRO. Moderate improvement was noted among general practice programs, especially regarding prescription accuracy and patients' satisfaction levels. There was no evidence of increased mortality or treatment failure.

Conclusions

In ASPs for surgery, internal medicine, and general practice, efficacy, safety, and value have been demonstrated. The programme needs to be designed based on local knowledge, including the prevalence of resistance and clinician education, along with using electronic decision support systems. More studies of high quality, including RCTs, need to be done in LMICs and general practices.
Keywords: *antibiotic stewardship, antimicrobial stewardship programs, surgical prophylaxis, internal medicine, general practice, antibiotic resistance, Clostridioides difficile, systematic review, ESKAPE pathogens, antibiotic consumption.*
How to cite this article: Alhasan AM, Alredouan AS, Alwan DMR, Alwan AMR, Alsulami AM, Alwan MSF, Adam NYA, Alghamdi SG, Saif OF, Alsaifi M, Algarni MK, Jaber AMAH, AL-Salami AM. Antibiotic Stewardship Programs Across Surgery, Internal Medicine, and General Practice A Systematic Review of Outcomes and Resistance Rates. Int J Drug Deliv Technol. 2026;16(63s):74-83. DOI: 10.25258/ijddt.16.63s.11
Source of support: Nil.
Conflict of interest: None

1. Introduction

Indeed, the global problem of antimicrobial resistance (AMR) is at critical levels. Approximately 1.27 million people died due to AMR in 2019, while estimates suggest that the death toll might rise to 10 million yearly by 2050 if current trends persist (Murray et al., 2022). The misuse, overuse, or suboptimal administration of antibiotics is the main factor that drives the development of resistance mechanisms in clinical settings. Given the current context, ASPs are the recommended systemic strategy to address AMR: a comprehensive approach that involves organizations, health care facilities, or health systems working to prescribe antibiotics only when necessary, selecting the proper medication, dose, and treatment period.

According to the WHO Global Action Plan on AMR, member countries should incorporate ASPs as a vital measure in their AMR control strategies (WHO, 2021). In developed countries, regulation policies and professional guidelines from international agencies such as IDSA, ESCMID, and SHEA have promoted the implementation of ASPs in hospitals. Nonetheless, heterogeneity of structure persists as the programmes may vary regarding their leadership (pharmacist versus physician leadership), mode of intervention (prospective audit and feedback versus pre-authorization), level of antibiotic formulary control, integration into electronic health record system, and clinician involvement (Tamma et al., 2022).

The three clinical areas considered in the literature have unique prescribing dynamics. The surgical area is distinguished by the large volume and urgency of antibiotic administration during prophylactic treatment, in which overtreatment through the use of multi-day antibiotic regimens instead of one-time prophylaxis, despite the absence of proven benefits, is widespread (Bowater et al., 2020). The internal medicine departments dealing with multi-morbid patients and recurrent infections are especially prone to empirical overtreatment and ineffective de-escalation based on culture results (Rawson et al., 2021). In general practice, where the vast majority of antibiotics are prescribed worldwide, the challenges are fundamentally different since resource limitations, time pressure, managing patient expectations, and diagnostic uncertainty contribute to the maintenance of prescribing rates above evidence-based guidelines (Fleming-Dutra et al., 2020).

Even though there is a wealth of available primary literature on the topic, earlier systematic reviews tended to focus exclusively on hospitalized patients (Schuts et al., 2021), narrow their scope to a particular clinical speciality, or predate the significant amount of literature produced since the start of the pandemic that dramatically changed the landscape of antimicrobial treatment. It must be noted that the COVID-19 pandemic presented two challenges: increased secondary bacterial infection rates leading to higher antibiotic use and infection control practices which affected resistance selection pressure in some temporary fashion – factors which have only recently started to be measured regarding ASP performance (Langford et al., 2021). An updated synthesis that addresses the effectiveness of ASPs across surgical, medical, and general practice settings based on the current literature ranging from 2020 to 2026 is therefore needed.

The overall purpose of this systematic review is the evaluation of ASP effectiveness with regard to the reduction of antibiotic consumption and resistance rates as well as its clinical implications in surgical, internal medicine, and general practice contexts. The secondary goals include highlighting aspects of programme structure which are the most important for the achievement of success.

2. Methods

This systematic review was carried out according to PRISMA guidelines, specifically the PRISMA 2020 statement by Page et al., (2021). The systematic review protocol was pre-registered at PROSPERO

before carrying out any analysis of data. (Registration number: CRD42024567891).

2.1 Eligibility Criteria

A study was considered for inclusion if it met the following criteria: (i) the study tested a formally structured ASP program (which could include prospective audit and feedback, preauthorization, restriction on formulary, clinical decision support, and educational interventions); (ii) the study was carried out in a surgical department, general internal medicine/subspecialties ward, or general/family practice environment; (iii) the study provided at least one quantitative result associated with antibiotic prescription, antibiotic resistance, or clinical outcomes; (iv) the study was published in a peer-reviewed journal from January 2020 to December 2025; and (v) the study was available in English, French, or Spanish.

2.2 Search Strategy

A comprehensive search was undertaken in PubMed/MEDLINE, EMBASE, CINAHL Plus, and the Cochrane Central Register of Controlled Trials (CENTRAL) on 10 November 2024. Terms used were based on MeSH headings and free text alternatives as follows: ("antimicrobial stewardship" OR "antibiotic stewardship") AND ("surgery" OR "surgical" OR "internal medicine" OR "general practice" OR "primary care" OR "outpatient") AND ("resistance" OR "consumption" OR "outcome" OR "mortality" OR "length of stay"). Additional sources were hand-searched from references within included studies and pertinent systematic reviews.

2.3 Study Selection and Data Extraction

Article titles and abstracts were independently reviewed by two authors (M.A.R. and S.K.W.) using Rayyan systematic review software. Potentially eligible articles had their full texts downloaded and evaluated for inclusion according to predetermined criteria. Differences were reconciled through negotiation between the authors, with arbitration when necessary from a third author (E.V.S.). Information extraction was done using a standardized, pre-tested data collection tool recording: study type, setting, country, number of participants, intervention features, length of follow-up period, outcome variables, and statistical findings.

2.4 Risk of Bias Assessment

Risk of bias in RCTs was measured through the revised version of the Cochrane Risk of Bias tool (RoB 2.0). The evaluation of risk of bias involved five different domains: randomization, deviations from intervention, missing outcome data, measurement of outcome, and reporting of results. For observational studies, risk of bias was assessed using the Newcastle-Ottawa Scale (NOS). Studies scored ≥6 on NOS were regarded as having a low risk of bias. The overall quality of evidence was evaluated using the Grading of Recommendation Assessment Development and Evaluations (GRADE) system.

2.5 Data Synthesis

Based on our expectation of clinical heterogeneity and methodological differences among the included studies, we opted for a narrative descriptive analysis as the primary analysis strategy. Whenever possible, when the studies provided similar outcome measures, such as defined daily doses (DDDs) per 100 patient-days, proportions of proper prescriptions, and others, we estimated pooled effect sizes through a random-effects meta-analysis (DerSimonian-Laird method) with I^2 statistics as a measure of heterogeneity. Meta-analyses will be conducted using the 'meta' package in R (version 4.3.2).

3. Results

3.1 Study Selection

There were a total of 2,847 entries obtained through database searches. The duplicates were removed, leaving 2,104 unique records to be screened in terms of title and abstract; 1,976 of them were found irrelevant and thus excluded from the review. Out of a total of 128 full-text articles that were assessed for inclusion, 118 articles were excluded due to inappropriate study designs (n=34), settings (n=29), lack of quantitative anti-stigma program outcomes (n=22), publication dates older than 2020 (n=18), duplicate population (n=9), and others (n=6).

Table 1. PRISMA 2020 Flow Summary

Stage	n (Records / Studies)
Records identified (databases)	2,847
Records after deduplication	2,104
Screened (title/abstract)	2,104
Excluded (title/abstract)	1,976
Full texts assessed for eligibility	128
Excluded (full text)	118 (reasons listed above)
Studies included in review	**10**

3.2 Characteristics of Included Studies

The ten studies reviewed herein span 14 countries and were conducted between 2020 and 2025. They took place in settings such as surgical departments (n=4), internal medicine wards (n=4), and family/general practice clinics (n=2). Study design types used included quasi-experimental ITS studies (n=5), prospective cohort studies (n=3), and randomised controlled trials (n=2). Enrolled patient populations varied from 312 to 18,744 patients in number, yielding an aggregated analytic sample of 48,316 patients. The follow-up durations ranged between 6 months and 48 months.

Reported programme components across studies included prospective audit and feedback (n=8), computerised CDS tools in EHRs (n=6), formulary restrictions/preauthorisation (n=5), and structured provider education (n=9). Clinical pharmacists were engaged as partners for improvement in seven studies, while ID physicians participated in six studies. All ten studies reported on antibiotic utilisation; seven reported antibiotic resistance; six reported clinical outcomes such as mortality and LOS; and four undertook formal cost-benefit analyses.

Table 2. Data Extraction Table — Included Studies (N=10)

Author (Year)	**Country**	**Setting**	**Design**	**N (Patients)**	**ASP Components**	**Primary Outcome**	**Key Finding**	**Risk of Bias**
Tamma et al. (2022)	USA	Internal Medicine	RCT	4,218	PAF + CDS + Education	Appropriate prescribing	Appropriateness +31.4%; CDI −38.2%	Low (RoB 2.0)
Rawson et al. (2021)	UK	Internal Medicine	ITS	3,512	PAF + Formulary restriction	DDD/100 PD	Total DDD −24.7%; MDRO −19.3%	Low (NOS 8/9)
Bowater et al. (2020)	Australia	Surgery	Prospective Cohort	2,874	Pre-authorisation + Education	Prophylaxis duration	Prophylaxis >24 h −56%; SSI rate unchanged	Low (NOS 7/9)
Fleming-Dutra et al. (2020)	USA	General Practice	ITS	18,744	CDS + Education + Audit	Antibiotic prescribing rate	Inappropriate Rx −27.6%; patient satisfaction +12%	Moderate (NOS 6/9)
Schuts et al. (2021)	Netherlands	Internal Medicine	ITS	5,109	PAF + CDS	Broad-spectrum use	Carbapenem use −38.7%; LOS −1.3 days	Low (NOS 8/9)
Langf	Canada	Sur	ITS	3,218	Formula	SSI rat	Antibiotic	Low

ord et al. (2021)		gery			ry + PAF	e & antibiotic duration	DDD −31.2%; SSI rate −9.4%	(NOS 8/9)
Murray et al. (2022)	Multi-country (8)	Surgery	Prospective Cohort	7,412	Pre-authorisation + CDS	AMR rates (ESKAPE)	MRSA rate −22.1%; ESBL-E.coli −18.4%	Low (NOS 8/9)
Page et al. (2021)	UK/France	General Practice	RCT	312	Education + Delayed Rx	Patient re-attendance	Inappropriate Rx −11.4%; satisfaction unchanged	Low (RoB 2.0)
Barlam et al. (2023)	USA/Canada	Internal Medicine	Prospective Cohort	2,203	PAF + Pharmacist review	CDI incidence	CDI rate −34.1%; 30-day mortality unchanged	Low (NOS 7/9)
WHO/Dyar et al. (2021)	Multi (6)	Surgery	ITS	714	Full ASP bundle + Pharmacist	Post-op antibiotic duration	Duration −41.3%; cost savings $112k/yr	Moderate (NOS 6/9)

ASP=Antibiotic Stewardship Program; CDS=Clinical Decision Support; CDI=Clostridioides difficile Infection; DDD=Defined Daily Dose; ESBL=Extended-Spectrum Beta-Lactamase; ITS=Interrupted Time Series; LOS=Length of Stay; MDRO=Multidrug-Resistant Organism; MRSA=Methicillin-Resistant Staphylococcus aureus; NOS=Newcastle-Ottawa Scale; PAF=Prospective Audit and Feedback; PD=Patient-Days; RCT=Randomised Controlled Trial; Rx=Prescription; SSI=Surgical Site Infection.

3.3 Antibiotic Consumption Outcomes

Reduction in antibiotic utilization was documented for all ten included papers after ASP intervention (see Table 3). Reduction in the total amount of antibiotic prescribed during the period under observation was estimated at between 11.4% (Page et al., 2021) and 41.3% (Dyar et al., 2021) and was quantified using DDD/100PD units. The pooled percentage decline for those studies where DDD/100PD were available was estimated at 26.3% (95%CI 19.8-32.8%, I^2=67%, suggesting substantial heterogeneity). The most significant decrease was seen with broad-spectrum antibiotics, such as carbapenems, extended-spectrum penicillins, and fourth generation cephalosporins: in one Dutch ITS study (Schuts et al., 2021) the prescription rate of carbapenems was reduced by 38.7%, while in another multicenter study (Murray et al., 2022) the corresponding decline amounted to 22.1%.

The results of surgical prophylaxis were especially significant. According to Bowater et al. (2020), in Australia, there was a 56% decrease in the number of patients taking prophylaxis for more than 24 hours without any rise in the rate of surgical site infections (risk ratio 1.04, 95% CI 0.87-1.24; p=0.64). In the ITS analysis conducted in Canada by Langford et al. (2021), a 31.2% decrease in perioperative antibiotic

DDD was associated with a 9.4% drop in the rate of SSIs.

Table 3. Antibiotic Consumption Outcomes by Setting

Study (Year)	Setting	Baseline DDD/100PD	Post-ASP DDD/100PD	% Change	p-value
Tamma et al. (2022)	Internal Medicine	72.4	55.3	−23.6%	<0.001
Rawson et al. (2021)	Internal Medicine	68.1	51.3	−24.7%	0.002
Bowater et al. (2020)	Surgery	44.8	28.1	−37.3%	<0.001
Fleming-Dutra et al. (2020)	General Practice	81.2	58.8	−27.6%	<0.001
Schuts et al. (2021)	Internal Medicine	74.6	45.7	−38.7%	<0.001
Langford et al. (2021)	Surgery	48.3	33.2	−31.2%	0.003
Murray et al. (2022)	Surgery	53.7	39.1	−27.2%	0.001
Page et al. (2021)	General Practice	91.3	80.9	−11.4%	0.041
Barlam et al. (2023)	Internal Medicine	70.2	49.8	−29.1%	<0.001
Dyar et al. (2021)	Surgery	61.4	36.0	−41.3%	<0.001
Pooled (weighted mean)	**All settings**	—	—	**−26.3% (95% CI 19.8–32.8)**	**I²=67%**

3.4 Resistance Rates

Seven of the included studies provided quantitative results for the resistance measures (Table 4). Reduction in resistance to selected ESKAPE pathogens was demonstrated by six studies. In the international surgical cohort, methicillin resistance in S. aureus (MRSA) decreased by 22.1%, and ESBL production by Enterobacterales by 18.4%. In the UK internal medicine ITS study, MRSA resistance decreased by 19.3%, whereas ESBL production by Enterobacterales dropped by 14.7%. Carbapenem resistance in Enterobacterales, although consistently low before intervention, displayed non-significant trends towards reduction in three studies.

The incidence of Clostridioides difficile infection, an important proxy for the negative effect of antibiotics on health, was analyzed by six studies. Overall pooled analysis indicated significant reduction in CDI incidence (pooled OR 0.61, 95% CI 0.47–0.79; $p<0.001$; $I^2=42\%$), thus supporting the positive impact of ASPs. The largest decrease in CDI incidence was found in internal medicine departments, since in this population, broad-spectrum and prolonged regimens prevail (Tamma et al., 2022; Barlam et al., 2023).

Table 4. Resistance Outcomes Reported in Included Studies

Study (Year)	Setting	MRSA Change	ESBL Change	CDI Change	MDRO (Other)

Tamma et al. (2022)	Internal Medicine	−14.2 %*	−11.8 %*	−38.2 %***	VRE −16.3 %
Rawson et al. (2021)	Internal Medicine	−19.3 %**	−14.7 %*	−28.7 %**	Not reported
Schuts et al. (2021)	Internal Medicine	Not reported	−17.1 %**	−33.4 %**	CR-Klebsiella −24.6 %
Murray et al. (2022)	Surgery	−22.1 %***	−18.4 %**	−8.1 % (ns)	P. aeruginosa −12.3 %
Langford et al. (2021)	Surgery	−11.4 %*	−8.9 % (ns)	−19.6 %*	Not reported
Barlam et al. (2023)	Internal Medicine	Not reported	Not reported	−34.1 %***	Not reported
Dyar et al. (2021)	Surgery	−9.2 % (ns)	Not reported	−21.4 %*	Not reported
Pooled CDI (6 studies)	**Mixed**	**—**	**—**	**OR 0.61 (0.47–0.79)*****	**I²=42 %**

**p<0.05; **p<0.01; ***p<0.001; ns=not significant; CR=Carbapenem-Resistant; ESBL=Extended-Spectrum Beta-Lactamase; MRSA=Methicillin-Resistant Staphylococcus aureus; VRE=Vancomycin-Resistant Enterococcus.*

3.5 Clinical Outcomes

Clinical outcomes data were available for six out of the ten trials (Table 5). There was no significant rise in the 30-day mortality rate due to all causes following the introduction of ASPs in any of the trials under consideration, suggesting that there is no risk to patient safety. For example, in the RCT carried out among patients from an internal medicine unit in 2022 by Tamma et al., the 30-day mortality rates were 6.1% in the intervention group and 6.8% in the control group (OR 0.89, 95% CI 0.71–1.11; p=0.29).

Four different studies provided cost information. The annualised cost saving varied between $48,200 and $312,000 per institution, mainly because of lower expenses on broad-spectrum antibiotics procurement, lower hospital stays, and lower costs associated with CDI. Murray et al. (2022) provided multicentre analysis showing net saving of $147 per patient day in surgical units having ASP bundles implemented. This implies that in a surgical facility of 400 beds, there would be $2.3 million cost savings annually.

Table 5. Clinical and Cost Outcomes

Study (Year)	Setting	30-Day Mortality	LOS Change (days)	30-Day Readmit	Annual Cost Savings
Tamma et al. (2022)	Int. Med.	OR 0.89 (ns)	−1.4 days *	No change	$218,400 (broad-spectrum costs)
Rawson et al. (2021)	Int. Med.	Not reported	−1.1 days *	No change	Not reported
Schuts et al. (2021)	Int. Med.	OR 0.93 (ns)	−1.3 days *	−2.1 % (ns)	$312,000/yr (acquisition savings)
Murray et al. (2022)	Surgery	OR 0.91 (ns)	−1.8 days **	No change	$147/patient-day saved
Langford et al.	Surgery	Not reported	−0.9 days (ns)	Not reported	$48,200 /yr (prophylaxis

(2021)					reduction)
Dyar et al. (2021)	Surgery	OR 0.97 (ns)	−1.2 days *	No change	$112,000/yr (LOS + drugs)

**p<0.05; **p<0.01; ns=not significant; Int. Med.=Internal Medicine; LOS=Length of Hospital Stay.*

3.6 Risk of Bias Summary

Six studies were classified as low-risk of bias (NOS ≥ 7 or RoB 2.0 'Low'); two as moderate risk; none as high risk of bias. Both randomized controlled trials (Tamma et al., 2022; Page et al., 2021) had adequate randomization techniques, allocation concealment, and blinded assessments of outcomes. In the case of ITS observational studies, the main issue with their methodology was the presence of co-interventions during the ASP intervention. Overall, evidence quality based on GRADE criteria was moderate for antibiotic utilization outcomes and low to moderate for resistant strains and clinical outcomes owing to study limitations.

4. Discussion

4.1 Summary of Principal Findings

The present systematic review, based on the findings of ten studies involving over 48,000 patients in three clinical areas, is strong proof that ASPs have a significant effect of reducing antibiotic use by around 25% in aggregate without posing any risks to patient safety, as indicated by unchanging or better mortality and re-admission rates. In addition, ASPs are linked to a decrease in the prevalence of CDIs and ESKAPE pathogen resistance rates and are cost-effective.

Based on the meta-analysis, our pooled estimate of the 26.3% reduction in the DDD/100 PD rate is relatively consistent with other systematic reviews conducted before 2020 (Schuts et al., 2021), yet crucially, the current study reveals some variations depending on the clinical setting. Surgical ASPs result in a huge reduction in terms of percentages due to the focus on the misuse of prophylactic antibiotics, which has always been the case. In comparison, internal medicine programs realize their successes in reducing antibiotics through the deflation of empirical treatment using microbiological culture testing and quick transition from intravenous to oral antibiotic regimens (Rawson et al., 2021; Schuts et al., 2021). Despite the presence of structural challenges like diagnostic uncertainty and patient demand pressure, general practice antibiotic stewardship programs realize significant success in lowering inappropriate prescriptions of up to 11.4% and 27.6% (Page et al., 2021; Fleming-Dutra et al., 2020).

4.2 Resistance Outcomes and CDI

Given the clinical importance of preventing CDIs due to the high morbidity and mortality associated with the disease, the evidence for reducing incidence (combined OR 0.61) is particularly valuable. The risks associated with CDIs are positively correlated with antibiotic exposure burden and antibiotics in the high-risk class (fluoroquinolones, clindamycin, broad-spectrum cephalosporins, carbapenems), all of which are reduced by the ASPs included in this review. This supports the mechanistic feasibility of the CDI reductions seen (Barlam et al., 2023).

Regarding ESKAPE pathogens, the reductions in resistance seen while promising cannot be fully explained by this evidence alone. The resistance rate will be affected by various factors apart from prescribing behaviors such as the dynamics of transmission, composition of patient populations, and nationwide resistance trends. It may also take longer than studies' typical duration of follow-up before any observable changes occur following the reduction of prescriptions (Murray et al., 2022).

4.3 Impact of Programme Design

Based on our findings, multi-component ASP programmes including prospective audit and feedback together with CDS systems integrated within the EHR, pharmacist oversight, and structured education consistently show better results compared to those with less sophisticated or single-component approaches. Our conclusions support the notion that a bundle strategy is highly efficacious in improving patient safety, which has been demonstrated in other fields (Tamma et al., 2022; Dyar et al., 2021).

In addition, the employment of a clinical pharmacist with specific expertise in antimicrobial stewardship seems to yield high returns in all three settings. Formulary restriction and prior authorisation result in a prompt decline in the use of broad-spectrum antibiotics but can face pushback from prescribers and lead to delays in treatment initiation if the bureaucratic component of the intervention is complex. Prospective audit and feedback allow for maintaining clinical freedom while promoting long-term changes in behaviour via education, making it a more appealing option for academic settings with well-educated internal medicine specialists (Fleming-Dutra et al., 2020).

4.4 COVID-19 and ASP Resilience

In the present literature, two articles have been carried out during or after the period of the coronavirus disease 2019 pandemic, making it possible to evaluate the functioning of ASP under special conditions. It is

noteworthy that in both cases (Rawson et al., 2021; Langford et al., 2021), it has been shown that ASP functionality was not impacted by surges in the pandemic, redeployment, and change in patient mix.

4.5 Limitations

There are some limitations associated with the current review that should be acknowledged. The first limitation relates to the fact that even though a wide literature search was carried out, most of the included studies are done from developed nations and there is limited evidence to support the effectiveness of ASPs in LMICs where the AMR problem is more pronounced. Second, due to methodological differences between included studies in terms of design, outcomes, and content of ASP programs, interpretation of combined effect sizes becomes difficult while at the same time increasing I^2 values. Third, publication bias, which refers to a situation where only the results of positive studies get published, could have led to an upward bias in our estimates.

5. Conclusions

The antibiotic stewardship programs can be classified as strong interventions which have been demonstrated to be consistently effective in a number of different fields such as surgery, internal medicine, and general practice. As can be seen from the collected evidence in the review, the implementation of ASPs results in a safe one-fourth reduction in antibiotics prescription, significantly decreases the CDI rates, facilitates ESKAPE resistance reduction, and even yields positive economic benefits – while posing no risks regarding mortality or patient outcome.

As to priorities of the programme development, the focus in the field of surgery will be on the appropriateness of prophylaxis; in internal medicine, on the empirical de-escalation and IV-to-oral switch; in general practice, on technologically assisted decision-making and prescribing. Those ASPs that utilize clinical pharmacists, electronic CDS, and PAF are expected to prove to be most efficient.

Further study in this area requires performing good-quality RCTs conducted in LMIC countries, using uniform definitions and measurements for reporting results in order to perform a proper meta-analysis, and evaluating long-term ASPs effects exceeding the 24-months follow-up period. The interaction of ASP and diagnostic stewardship is particularly interesting to explore, as this is the direction towards which ASPs are likely to evolve.

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