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Narrative Review

Antimicrobial Stewardship Program at a Tertiary Care Hospital: A Road Less Travelled

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ABSTRACT

The manuscript provides a practical overview of implementing an antimicrobial stewardship program from a very nascent stage to a well-established program in the complex setting of a tertiary care hospital. It gives the readers a road map to initiate or refine their journey utilizing many principles of quality improvement, common sense, and negotiating complex human behavior. It also showcases a good use of the scientific principles of quality improvement and change management. Starting small with well-defined surgical prophylaxis paved the way for the complex world of empirical prescription of antimicrobials later in this journey. Various strategies like prescription audit and feedback, handshake stewardship, antimicrobial time-out, and greater mindfulness towards antimicrobial prescription have been well highlighted. Regular point prevalence surveys provided us with actionable data for multiple interventions. Moreover, it highlights the well-defined process and outcome metrics that measured the various aspects of antimicrobial prescription and were instrumental in assessing the success or challenges in implementing the program. Compliance with surgical prophylaxis improved from 34 % to 71%, while compliance with de-escalation increased from 38% to 57%.

KEYWORDS: Antimicrobial stewardship; Antimicrobial time-out; Prospective audit and feedback; SAFE approach; Lead antimicrobial pharmacist; Antibiotic chart

INTRODUCTION

Ours is a 350-bed, 22-year-old tertiary care hospital situated in north India. Our Antimicrobial Stewardship (AMS) journey started about fifteen years back when we realized that we were increasingly encountering drug-resistant infections in our patients and losing some of them to these infections. The clinicians, in all their wisdom to cure their patients, were often using 'higher-end' antibiotics to ensure that their patients recovered faster. The surgeons were prescribing 'prophylactic' antibiotics for elective clean surgeries for almost a week and often at discharge, too. Everybody was doing their best to help the individual patients at hand, but our very actions to help were backfiring, with our drug resistance continuing to rise. About fifteen years back, we started with our AMS program. In this article, we share our journey and learnings, hoping it may serve as a roadmap for the newer hospitals embarking upon their AMS journey.

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HOW DID WE START?

We started with the lowest-hanging fruit, our surgical prophylaxis (SP) practices.[1] When we started, the antibiotics intended to be given as SP were continued for almost seven days and often continued at discharge. Broad-spectrum antibiotics were frequently given as SP. Realizing the need for a change, we reviewed the literature on surgical prophylaxis, collected the initial baseline data, and engaged with our surgical colleagues to build a consensus. Brainstorming sessions were held with surgeons, and evidence-based consensus was agreed upon and implemented. Our head of the Anaesthesia department was entrusted with the responsibility for this initiative. To begin with, monthly focussed audits were initiated for SP practices in 3 surgical specialties: coronary artery bypass grafting (CABG), total knee replacement (TKR), and laparoscopic cholecystectomy. Type, time of administration before surgical incision, and the duration of antibiotic(s) were looked explicitly into for compliance. A special note was also made regarding antibiotics prescribed at discharge. Compliance with these metrics was shared with respective shareholders and the medical administration at periodic intervals.

Many challenges were faced during the implementation phase, requiring multiple meetings with various specialties to address the concerns. In some specialties like CABG, it was the choice of antimicrobials; in others, it was the duration. It also required the simultaneous involvement of infection control, engineering, and central sterile supply department (CSSD) teams with the surgical teams to generate confidence in the operating room practices to reduce the fallback on antimicrobials as a risk reduction strategy. In certain specialties, a trade-off was also worked out between the clinical and administrative teams where the administration agreed to a particular brand of narrow-spectrum original antimicrobial in exchange for a reduced duration of the SP. Gradually, significant gains have been seen in our SP practices over the last few years, and the scope of surveillance now includes the following ten surgical specialties: CABG, TKR, craniotomy, laparoscopic cholecystectomy, hernia repair, cesarean section, spine surgery, renal transplant, vascular surgery – Arterio-venous (AV) fistula, and pediatric cardio-thoracic vascular surgery.

The core team addressed the medical antimicrobial prescriptions after finding success and streamlining the surgical prophylaxis. This was a significant challenge as our tertiary care center has to deal with referred and complicated cases from other hospitals with exposure to most classes of antimicrobials. The hospital has open intensive care units (almost 60% of the total bed strength of the hospital) with consultant-based practice – both employed and empaneled. This form of engagement had its challenges and advantages.

To define our areas of intervention, we needed to study our antimicrobial prescription patterns. Point Prevalence Surveys were conducted based on a defined tool, which captured various aspects of the antimicrobial prescription, including reasons for starting antimicrobials, combinations, number, duration, culture before starting antimicrobials, periodic review with labs, de-escalation, etc. A written document expressing the vision of our program, requirements, and measurables was created and shared with the management to request the necessary resources. A Lead Pharmacist with a keen interest in this field was appointed as a critical resource. A senior clinician intensivist with good standing and rapport with the medical fraternity was chosen as the champion for this initiative.

The first task was to expand the scope of our antimicrobial policy beyond surgical prophylaxis to include guidance on the empirical use of antimicrobials.[2] The local antibiogram, Indian Council of Medical Research (ICMR) guidance on rational use of antimicrobials,[3] and tenets of good antimicrobial prescription were combined to create a syndrome-wise antimicrobial policy. Multiple specialty-wise meetings were held with all the stakeholders, and their inputs and suggestions were considered before finalizing the document. The document was shared with all the stakeholders and made available on all the hospital desktops for easy future reference. The document has since been updated every two years.To ensure the mindful usage of certain broad-spectrum or high-end antimicrobials, we categorized them into restricted and limited access categories and started monitoring their use. Justification forms were required to be filled for the drugs in the restricted category, while the consumption data alone was tracked for the ones in the limited access category. This enabled us to optimally utilize our human resources towards fewer critical drugs. The justification had to be provided in a decision-making tool within two days of prescription (Figure 1). A system-generated alert to the prescribers and manual oversight by the pharmacy team was also implemented. The antimicrobials were not withheld at any point. These forms were also analyzed to understand the rationale and pattern of using these antimicrobials. Following this, appropriate action of engagement and education was taken where required.

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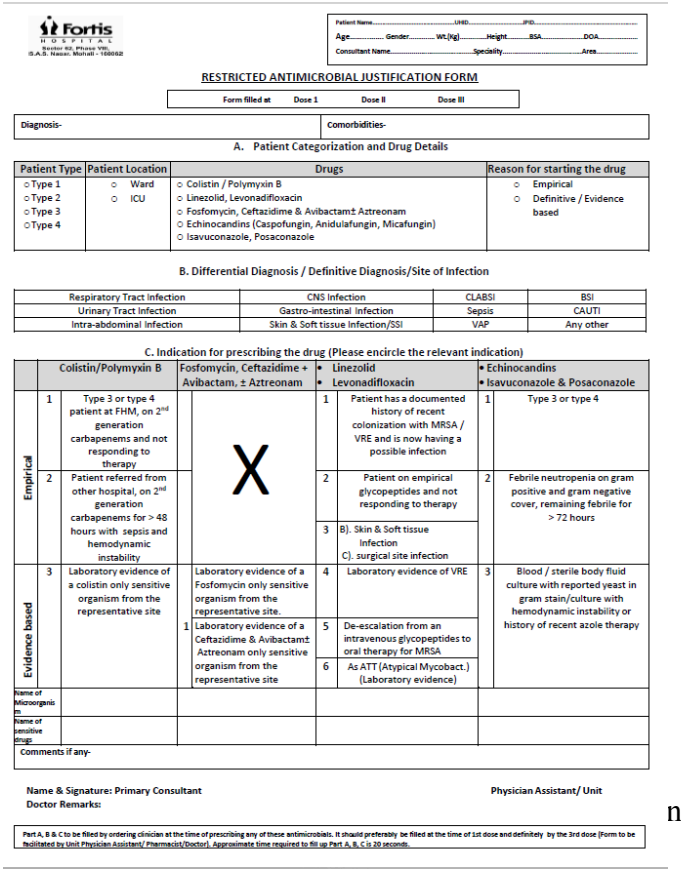

Fortis HOSPITAL

Patient Name..... UHID..... IPID.....
Age..... Gender..... Wt.(kg)..... Height..... BSA..... DOA.....
Consultant Name..... Speciality..... Area.....

RESTRICTED ANTIMICROBIAL JUSTIFICATION FORM

Form filled at Dose I Dose II Dose III

Diagnosis- Comorbidities-

A. Patient Categorization and Drug Details

Patient Type	Patient Location	Drugs	Reason for starting the drug
○ Type 1 ○ Type 2 ○ Type 3 ○ Type 4	○ Ward ○ ICU	○ Colistin / Polymyxin B ○ Linezolid, Levonadifloxacin ○ Fosfomycin, Ceftazidime & Avibactam± Aztreonam ○ Echinocandins (Caspofungin, Anidulafungin, Micafungin) ○ Isavuconazole, Posaconazole	○ Empirical ○ Definitive / Evidence based

B. Differential Diagnosis / Definitive Diagnosis/Site of Infection

Respiratory Tract Infection	CNS Infection	CLABSI	BSI
Urinary Tract Infection	Gastro-intestinal Infection	Sepsis	CAUTI
Intra-abdominal infection	Skin & Soft tissue Infection/SSI	VAP	Any other

C. Indication for prescribing the drug (Please encircle the relevant indication)

		Colistin/Polymyxin B	Fosfomycin, Ceftazidime + Avibactam, ± Aztreonam	• Linezolid • Levonadifloxacin	• Echinocandins • Isavuconazole & Posaconazole
Empirical	1	Type 3 or type 4 patient at FHM, on 2nd generation carbapenems and not responding to therapy	X	1 Patient has a documented history of recent colonization with MRSA / VRE and is now having a possible infection	1 Type 3 or type 4
	2	Patient referred from other hospital, on 2nd generation carbapenems for > 48 hours with sepsis and hemodynamic instability		2 Patient on empirical glycopeptides and not responding to therapy 3 B). Skin & Soft tissue Infection C). surgical site infection	2 Febrile neutropenia on gram positive and gram negative cover, remaining febrile for > 72 hours
Evidence based	3	Laboratory evidence of a colistin only sensitive organism from the representative site	Laboratory evidence of a Fosfomycin only sensitive organism from the representative site. 1 Laboratory evidence of a Ceftazidime & Avibactam± Aztreonam only sensitive organism from the representative site	4 Laboratory evidence of VRE 5 De-escalation from an intravenous glycopeptides to oral therapy for MRSA 6 As ATT (Atypical Mycobact.) (Laboratory evidence)	3 Blood / sterile body fluid culture with reported yeast in gram stain/culture with hemodynamic instability or history of recent azole therapy
Name of Microorganism					
Name of sensitive drugs					

Comments if any-

Name & Signature: Primary Consultant Physician Assistant/ Unit
Doctor Remarks:

Part A, B & C to be filled by ordering clinician at the time of prescribing any of these antimicrobials. It should preferably be filled at the time of 1st dose and definitely by the 3rd dose (Form to be facilitated by Unit Physician Assistant/ Pharmacist/Doctor). Approximate time required to fill up Part A, B, C is 20 seconds.

D. Review by Antimicrobial Stewardship (AMS) Committee

Clinical Parameters

Risk stratification done?	Yes/No	If Yes mentioned-
Appropriately documented diagnosis?	Yes/No	If Yes mentioned-

Laboratory Evidence

cultures sent before starting antimicrobials	Yes	No	If yes	Blood	Urine	Resp.	others
			Representative sample sent			Yes	No
Other markers of infection	Yes	No	Fever- Yes/No (If yes) , value-				
Biomarkers values (Most Relevant with 24 hours of starting antimicrobials)	TLC						
	CRP						
	PCT						
	Others						

Radiologic Evidence

Antimicrobial Therapy

Was the empirical antibiotic changed within 48 hrs. of start of therapy	Yes	No	Not applicable
If yes , specify reasons :			
Optimal dose?	Yes	No	

Antimicrobials Therapy

S.No	Drug	Dose	Route	Frequency	Start date	Stop date	DOT	Appropriate Dose (Y/N)
1.								
2.								
3.								
4.								
5.								
Any Therapeutic Duplication-Yes/No								

Rationale of Antimicrobials

Prescribed Antimicrobials	Justified	Not justified
If Not Justified , reasons		

Action taken (by Clinician) after discussion with the AMS team

Deescalated	Yes	No	Comments:
Continued	Yes	No	
Stopped /changed	Yes	No	

(AMS Team) Name..... Signature..... Date.....

FHM/Restricted AIF_09.2023/1.3

The rationale behind the justification form process was to promote mindfulness over a period of time amongst the prescribers to use these antimicrobials judiciously. Initially, four drugs were categorized as restricted antimicrobials at our hospital (linezolid, polymyxins, fosfomycin, and echinocandins). Lately, ceftazidime-avibactam, aztreonam, levonadifloxacin, isavuconazole, and posaconazole have also been added to this list.

Carbapenems, tigecycline, vancomycin, teicoplanin, daptomycin, and amphotericin B were initially categorized as limited access antimicrobials; minocycline and voriconazole too, have lately been added to this list.

The measurable parameters for the AMS program were identified into process and outcome metrics to look comprehensively at the prescription of antimicrobials.

Process metrics:

i. The rationale for starting empirical antimicrobials
ii. Appropriate cultures before starting antimicrobials
iii. Inappropriate combination
iv. Therapeutic Duplication
v. Simultaneous prescription of >= three antimicrobials
vi. Review of antimicrobials once the culture reports are received
vii. De-escalation

Outcome metrics

i. Total antimicrobial consumption
ii. Defined daily dose (DDD) and days of therapy (DOT)
iii. Drug resistance index (DRI)

Our first Point Prevalence Survey (PPS), in 2107, was based on a tool that included all the above facets of antimicrobial prescription, and we have been participating in all the global PPS surveys conducted since then. These PPS surveys brought forth the low-hanging fruit to be targeted and thus work on those actionables. We also collected and collated the historical annual data on antimicrobial consumption and resistance amongst five key bacterial pathogens and determined the drug resistance index. This served as the baseline data for the outcome parameters we intended to monitor.

Date			Auditor				ADDRESSOGRAPH/ Consultant	
Ward /Unit		**Speciality**			**Age /Sex**	**Weight**	**DOA**	**Present LOS**
Diagnosis								
Comorbidities								
Patient on Antimicrobials		Yes	No		**DD- AMA**		Mentioned	Not mentioned
Risk stratification done		Yes	No		CNS	RTI	VAP	SSI
Category of patient	1	2	3	4	GI/ IA	UTI	CAUTI	Any other
Indications for AMA mentioned		Yes	No		Skin&soft tissue	BSI	CLABSI	
Indication (Yes)	**Empirical**	**Evidence**	**SP**	**If yes**	SP	APP / Inapp	**Start date of AMA**	
Repeat cultures sent before Empirical AMA		Yes	No	**If yes**	Blood	Urine	Resp	others
Positive cult Y / N(if Yes Name of organism & site)			1 2 3					
No of AMA on the day of audit		1	2	3	>3	Antifungals	Yes	No
3 AMA for more than 3 days		Yes	No		**LOS> 10 DAYS**	Yes / No	**AMA> 10 days**	Yes / No

Figure 2: Screenshot of the Excel tool used for point prevalence surveys (PPS)

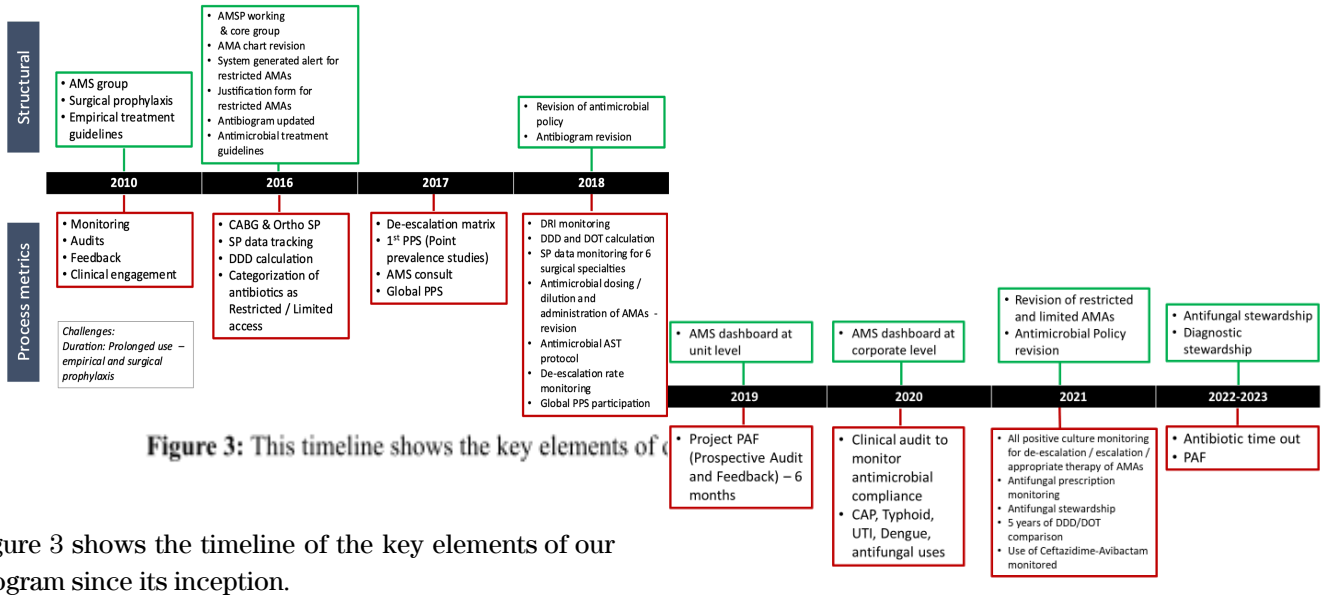

Figure 3: This timeline shows the key elements of

Figure 3 shows the timeline of the key elements of our program since its inception.

CORE ELEMENTS OF OUR PROGRAM

Our organization has put AMS as one of the key performance areas of the leadership, including the Chief Executive Officer (CEO).

The CEO is accountable to the board regarding the outcomes of the program. AMS dashboard (Figure 4) captures the key elements monitored at the board level for every hospital in the network. This ensures a robust governance mechanism at the organization level.

AMS steering committee is the local group responsible for the design and review of the program. It is a multidisciplinary group with representation from clinical and medical administration departments.

The recommendations are shared with the Infection control, Quality steering committees, and respective stakeholders. This working group meets monthly, and the proceedings are documented and shared (Figure 5).

AMS core group is the functional arm of this committee and consists of a senior intensivist, infectious diseases physician/ internal medicine consultant, microbiologists and infection Control Officer (ICO), clinical pharmacologist, lead antibiotic pharmacist, and

Process measurable	Surgical prophylaxis	AMS structure
1. % cases where appropriate cultures sent before Abx 2. % Cases where Justification forms filled 3. % Cases where preauthorisation done for restricted antimicrobials beyond 3 doses 4. % Cases where de-escalation & escalation done 5. % Cases where > 3 antimicrobials given for more than 3 days	1. % cases where appropriate choice of drugs 2. Time of administration 3. Dose of SP drug 4. Duration of SP drug	1. Working group meeting 2. AMS education activities 3. Antibiogram revision 4. Abx policy revision

Figure 4: Our AMS Dashboard.
These elements are tracked at the central level for each hospital in the network monthly. Each unit is scored and assessed accordingly.

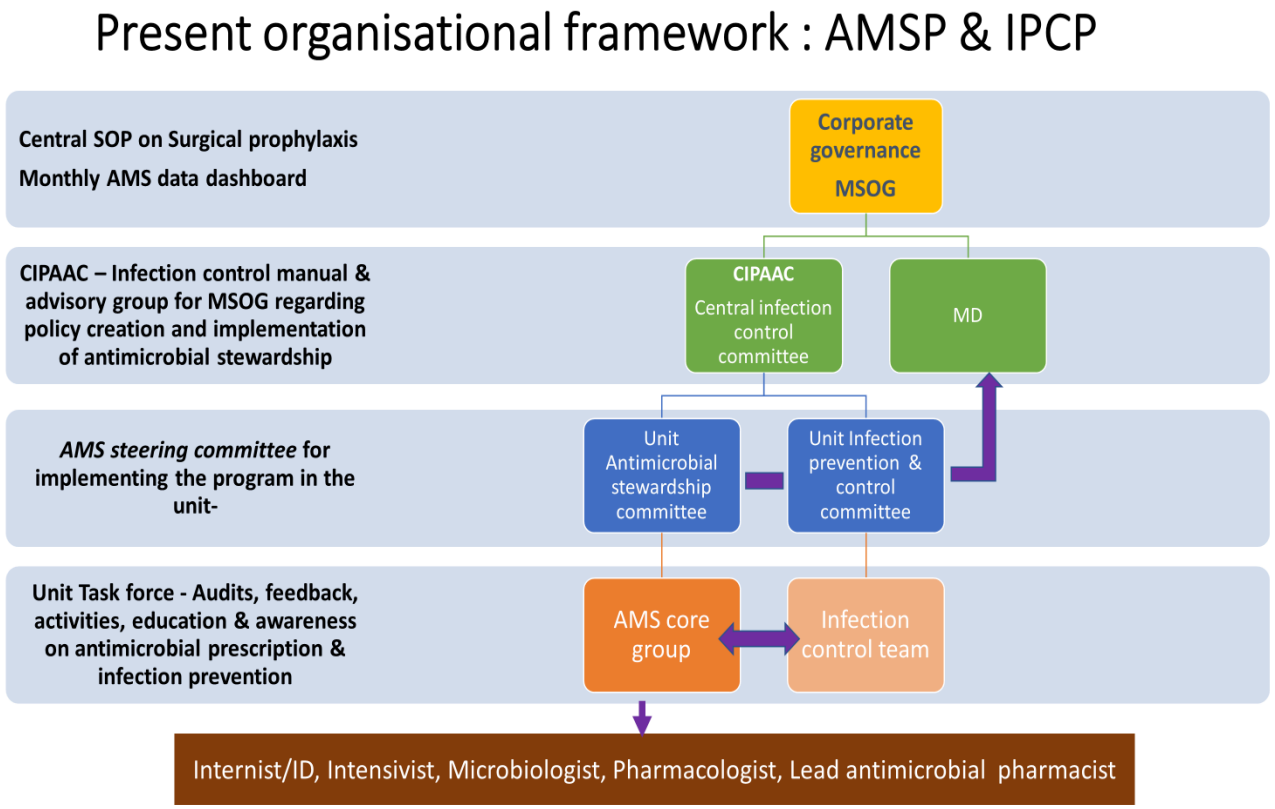

Figure 5: Our organizational framework for the antimicrobial stewardship program and Infection prevention and control program

an infection control nurse. This core group meets informally on almost a daily basis.

Surveillance audits, Accessibility, Feedback, and Education through engagement (SAFE) are the four cornerstones of our program. This *SAFE* approach has helped provide a strong foundation for our program and helped it earn respect and credibility within the hospital and outside.

***Surveillance audits* are undertaken for the following:**

1. Surgical prophylaxis, as recommended in the hospital's antibiotic policy
2. Compliance with process and outcome metrics defined for the prescription of empirical therapy.
3. Compliance with policy recommendations on empirical prescription of antimicrobials (syndromic approach)

Accessibility of members of the AMS core group to all the prescribers 24x7 for any antimicrobial-related query has helped to gain prescriber buy-in regarding the antimicrobial policy recommendations. AMS team provides consultation and support to clinical teams for judicious use of antimicrobials in difficult cases.

Feedback forms the bedrock of our program. We've seen that proactive feedback given with the patient's interest in mind is readily accepted and fosters collegial bonding between the stakeholders, thus enriching the organization's overall culture. Lead antibiotic pharmacist looks for opportunities for improvement concerning antimicrobials. Any deviations are corrected or escalated to the treating unit and the AMS team for corrective actions. *Prospective audit and feedback* has been a beneficial strategy for us and will be discussed in depth in the next section.

Education through engagement is an ongoing endeavor at our hospital. Clinical staff are educated on the rational use of antimicrobials through interactive sessions, classroom teachings, or case discussions. Medical trainees are given particular focus. Antibiotic Awareness Week is celebrated yearly to raise awareness about rational use amongst the medical fraternity and the community. Nurses ensure that the cultures are taken and sent before administering antimicrobials. Training on appropriate techniques for the collection of cultures is periodically undertaken.

GAME CHANGERS IN OUR ANTIMICROBIAL STEWARDSHIP PROGRAMME (AMSP)

These are some of the granular elements that were able to give visible momentum to the program.

Dedicated colour-coded antibiotic chart:

When our hospital started, antimicrobials used to be charted along with the other drugs in one combined order sheet. In the absence of electronic medical records (EMR), this would make manual tracking of antimicrobial prescriptions difficult and time-consuming. Separate color-coded (light green) antimicrobial prescription sheets were introduced, and have now been incorporated into every patient's medical history (Figure 6).

Apart from the essentials related to the prescribed antimicrobial (Name, dose, route, frequency, generic name, starting date), these sheets include

i. Risk stratification of patients based on their previous antibiotic consumption history (Category I/II/III/IV)[4]

ii. Indications for antimicrobials (Disease condition requiring antimicrobials)

iii. Type of prescription – empirical/ surgical prophylaxis/targeted

iv. Were appropriate cultures sent before the administration of antimicrobials?

v. Review of antimicrobials on days 3, 7 and 10

vi. Antimicrobial susceptibility testing protocol

vii. Antimicrobial dilution protocol

The introduction of these sheets not only enabled more mindful antimicrobial prescriptions but also helped significantly in the antimicrobial audit process.

Lead antimicrobial pharmacist:

Clinical pharmacists have always been a part of our hospital. However, their role and responsibility has been gradually expanding. One of these clinical pharmacists was earmarked as the 'Lead antimicrobial pharmacist' and given the additional responsibility of explicitly focusing on antimicrobial usage. Being the senior among all the clinical pharmacists and having an inclination and dedication to self-learning and growth, he has contributed immensely to our program. He is now the custodian of our antimicrobial consumption data and spearheads both the 'prospective audit and feedback' and 'antimicrobial time-out' processes mentioned below. Many prescribers now directly seek his advice related to drug choice, dosages, and interactions. While focused training on antimicrobials for pharmacists would be an essential step forward, the absence of it should not be a deterrent, as the passion and commitment of pharmacists can more than makeup for it.

Prescriber engagement:

Our program has valued dialogue over demand and engagement over compulsion. From the first baby step

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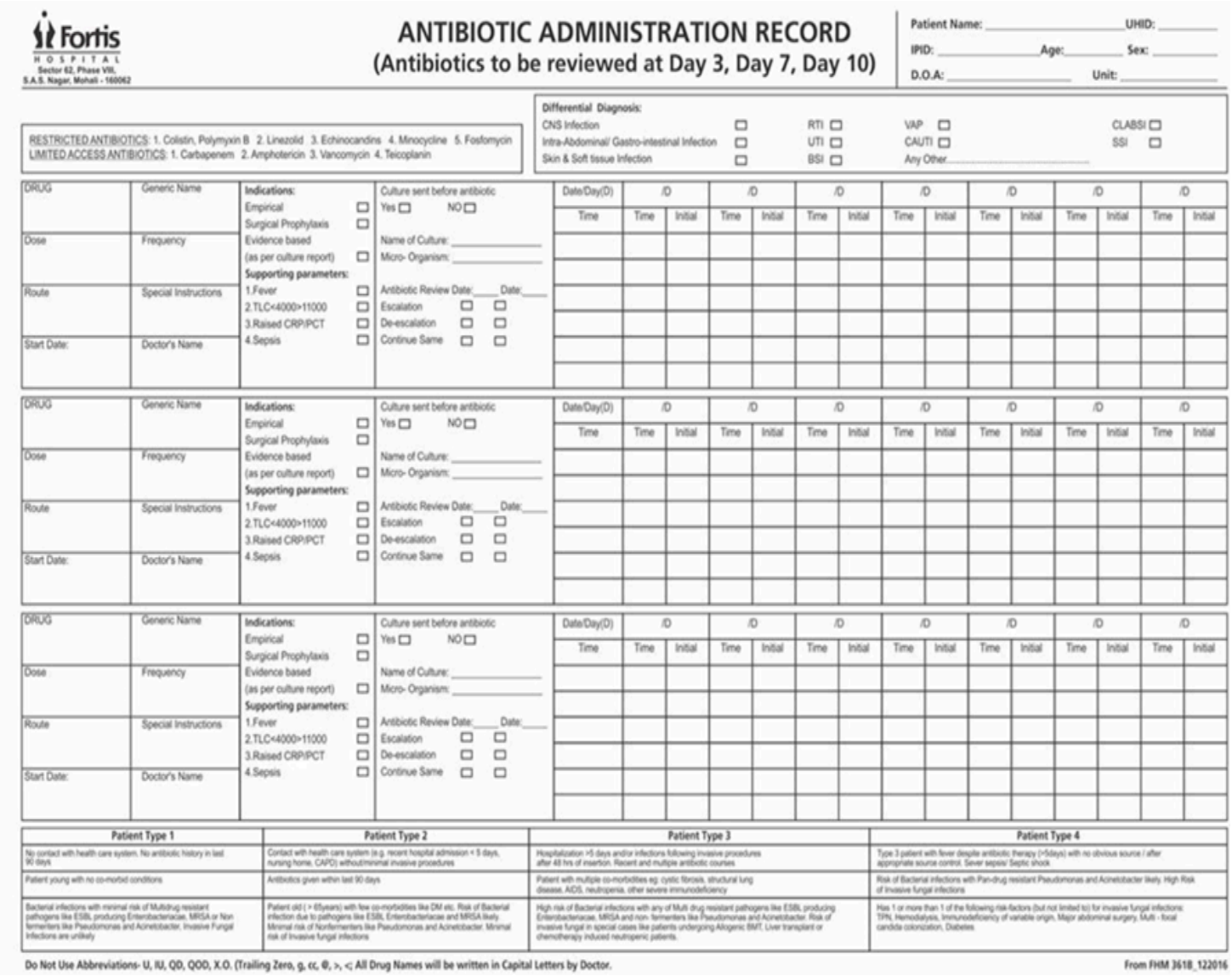
of surgical prophylaxis to drafting the hospital's antimicrobial policy and ensuring that this policy is followed, prescriber and stakeholder engagement has been the way for our program. Concepts of 'Handshake stewardship' and 'IKEA effect' have added to our conviction that this path,[5,6] though more challenging to begin with and surely more time-consuming, eventually leads to longer-lasting and more durable results.

broad-spectrum antimicrobial usage, and antimicrobial cost.[8] This intervention has been found useful even in the pediatric setting.[9]

In 2019-2020, we did a six-month project on Prospective audit and feedback. As part of this project, all inpatients with a positive blood culture report were followed up prospectively by the AMS team (helped by



Fortis HOSPITAL Sector 62, Phase VIII, S.A.S. Nagar, Mohali - 160062

ANTIBIOTIC ADMINISTRATION RECORD
(Antibiotics to be reviewed at Day 3, Day 7, Day 10)

Patient Name: _____ UHID: _____
IPID: _____ Age: _____ Sex: _____
D.O.A: _____ Unit: _____

RESTRICTED ANTIBIOTICS: 1. Colistin, Polymyxin B 2. Linezolid 3. Echinocandins 4. Minocycline 5. Fosfomycin
LIMITED ACCESS ANTIBIOTICS: 1. Carbapenem 2. Amphotericin 3. Vancomycin 4. Teicoplanin

Differential Diagnosis:
CNS Infection ☐ RTI ☐ VAP ☐ CLABSI ☐
Intra-Abdominal/ Gastro-intestinal Infection ☐ UTI ☐ CAUTI ☐ SSI ☐
Skin & Soft tissue Infection ☐ BSI ☐ Any Other_____

DRUG | Generic Name | Dose | Frequency | Route | Special Instructions | Start Date: | Doctor's Name

Indications: Empirical ☐ Surgical Prophylaxis ☐ Evidence based (as per culture report) ☐
Supporting parameters: 1.Fever ☐ 2.TLC<4000>11000 ☐ 3.Raised CRP/PCT ☐ 4.Sepsis ☐

Culture sent before antibiotic Yes ☐ NO ☐
Name of Culture: _____ Micro- Organism: _____
Antibiotic Review Date:____ Date:____
Escalation ☐ ☐ De-escalation ☐ ☐ Continue Same ☐ ☐

Date/Day(D) | /D | Time | Time | Initial | ... | Time | Initial

Patient Type 1	Patient Type 2	Patient Type 3	Patient Type 4
No contact with health care system. No antibiotic history in last 90 days	Contact with health care system (e.g. recent hospital admission < 5 days, nursing home, CAPD) without/minimal invasive procedures	Hospitalization >5 days and/or infections following invasive procedures after 48 hrs of insertion. Recent and multiple antibiotic courses	Type 3 patient with fever despite antibiotic therapy (>5days) with no obvious source / after appropriate source control. Sever sepsis/ Septic shock
Patient young with no co-morbid conditions	Antibiotics given within last 90 days	Patient with multiple co-morbidities eg. cystic fibrosis, structural lung disease, AIDS, neutropenia, other severe immunodeficiency	Risk of Bacterial infections with Pan-drug resistant Pseudomonas and Acinetobacter likely. High Risk of Invasive fungal infections
Bacterial infections with minimal risk of Multidrug resistant pathogens like ESBL producing Enterobacteriacae, MRSA or Non fermenters like Pseudomonas and Acinetobacter. Invasive Fungal Infections are unlikely	Patient old (> 65years) with few co-morbidities like DM etc. Risk of Bacterial infection due to pathogens like ESBL Enterobacteriacae and MRSA likely. Minimal risk of Nonfermenters like Pseudomonas and Acinetobacter. Minimal risk of Invasive fungal infections	High risk of Bacterial infections with any of Multi drug resistant pathogens like ESBL producing Enterobacteriacae, MRSA and non- fermenters like Pseudomonas and Acinetobacter. Risk of invasive fungal in special cases like patients undergoing Allogenic BMT, Liver transplant or chemotherapy induced neutropenic patients.	Has 1 or more than 1 of the following risk factors (but not limited to) for invasive fungal infections: TPN, Hemodialysis, Immunodeficiency of variable origin, Major abdominal surgery, Multi - focal candida colonization, Diabetes

Do Not Use Abbreviations- U, IU, QD, QOD, X.O. (Trailing Zero, g, cc, @, >, <; All Drug Names will be written in Capital Letters by Doctor.

From FHM 3618_122016

Figure 6: A dedicated antimicrobial administration chart used for every inpatient on antimicrobial(s) at our hospital.

Prospective audit and feedback (PAF): Prospective audit and feedback is the most widely accepted and effective AMS strategy. Though labor-intensive, it relies on 'immediate concurrent feedback' and offers rich dividends.[7] It has been shown to help decrease the average length of stay,

two clinical pharmacy interns) to see if action was taken upon that positive report. A dialogue with the clinical team was undertaken wherever we found that any action in the form of escalation/de-escalation was warranted but had yet to be taken by the treating team. This project helped us understand our baseline

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de-escalation rate and the impact of PAF on improving this rate.

Subsequently, post-COVID, PAF has become a standard of care at our hospital, and our lead antimicrobial pharmacist follows up with all inpatients with positive cultures and initiates dialogue with the treating teams where needed. In situations where he cannot effect a change at his own level, the matter is escalated to senior AMS team members, who then evaluate the situation and initiate a dialogue with the treating team. In every situation, the decision of the treating team remains final, and no change is forced upon the treating team. Their reasons for not agreeing with the AMS team's recommendations are documented. The following are considered as de-escalations.

i Broad-spectrum to narrow-spectrum antimicrobial.
ii Multiple drugs to a lesser number of drugs
iii Intravenous to oral
iv Stoppage of antimicrobials

Antimicrobial time-out (ATO):

This year, in 2023, we have introduced a new concept of 'antimicrobial time-out' in our hospital. Unlike PAF, which is more of a 'third party intervention,' ATO involves structured mindfulness towards antimicrobial prescription by the prescribers themselves during the routine clinical rounds.[10] It is more of a self-stewardship mechanism, like the pre-surgery time-out concept, which has become almost a norm. It has been shown to promote critical thinking on the part of the prescribers.[11] Initial hand-holding by the clinical pharmacists by way of pharmacist-led antimicrobial time-out has been reported to be beneficial because of the consistency and knowledge base that they provide to the system.[12]

We started ATO in one of our ICUs and are taking it to the other ICUs in a phased manner. This, again, is spearheaded by our lead antimicrobial pharmacist. Every patient admitted to the ICU is audited on the day of admission for the correctness of antimicrobial prescription in terms of the choice, dose, route, frequency, and drug-drug interactions. Any change, if warranted, is communicated to the treating team, and the prescription is modified to prevent the error from reaching the patient. Once the cultures are back, the patient is followed up again on day 3 or 4 to see if any change in the antimicrobial prescription is warranted. The same step is repeated on day 7 or 8 and at the time of discharge from the ICU to see if the antimicrobials can be stopped. This multi-step pharmacist-driven antimicrobial time-out has further enhanced the role and acceptance of the lead antimicrobial pharmacist in our hospital and contributed significantly towards our AMS program.

OUR KEY ACHIEVEMENTS

Though the final goals of our program are yet to be achieved, we have indeed been able to earn small but worthwhile wins that have laid a strong foundation for our program. The biggest achievement has been the 'visibility' of the AMS team, with many prescribers actively seeking inputs from the core AMS team members in antimicrobial-related queries.

Surgical prophylaxis and de-escalation have been our biggest gains in process metrics. Starting from a situation where SP was often prescribed for almost a week, and broad-spectrum antimicrobials were at times used for this purpose, we are now in a position much closer to the international benchmarks in this context. The concept of de-escalation, too, has seen a similar paradigm shift. Therapeutic duplication has decreased, and inappropriate antimicrobial combinations are used less often. Lately, we have started monitoring our compliance with our antimicrobial policy for a select subset of patients and have found it to be good (>95%). Though we have seen an improvement in the use of cultures and the appropriate filling up of justification forms, we still need to meet our expectations and benchmarks in these two areas. (Table 1)

Regarding the outcome metrics, we have seen improvement in using restricted and limited access antimicrobials. Our Drug resistance index (DRI) has also improved slightly. Lately, we have started capturing our multidrug resistance organisms (MDRO) rate per 1000 patient days. Improvement in this parameter would be an accurate indicator of the success of our program.

OUR CHALLENGES AND LEARNINGS

Apart from the human behavioral elements that can be a challenge to any program, the key hurdles that we faced in establishing our program have been:

Surgical site infections: Any infection in a surgical case made the surgical team return to their previous practice and prolong the duration of surgical prophylaxis. This stems out of fear of SSI and its ensuing fallouts like increases in morbidity, mortality, costs of treatment, and medico-legal liability.

High MDRO rate: Being a tertiary care hospital, we receive critically ill patients who either have a documented MDRO infection or are already on broad-spectrum antimicrobials before coming to us.

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Choosing a narrower spectrum empirical antibiotic for them becomes a challenge at times.

Table 1: Impact of our AMSP on the various process and outcome metrics
AMSP: Antimicrobial stewardship program, RTI: Respiratory tract infections, UTI: Urinary tract infections, BSI: Bloodstream infections, DDD: Defined daily dose, DOT: Days of therapy, DRI: Drug resistance index

Serial No.	Parameters	2008, Before AMSP initiation	2017, Relaunch of AMSP	2023, Present
	Process Metrics			
1	Appropriate cultures before starting antimicrobials	Not Monitored	69% (n=2484/3600)	87% (n=3619/4131)
2	Justification form for restricted antimicrobials	Not Monitored	39% (n=402/1032)	88% (n=1045/1187)
3	De-escalation	Not Monitored	38% (n=183/480)	57% (n=396/701)
4	Inappropriate antimicrobial combination	Not Monitored	0.5% (n=36/7200)	0.1% (n= 10/9000)
5	Therapeutic Duplication	Not Monitored	0.4%(n=29/7200)	0.1%(n=12/9000)
6	>= 3 antimicrobials Prescription	Not Monitored	2%(n=144/7200)	3% (n=256/9000)
7	Appropriate antimicrobials prescription (Lab Culture based)	Not Monitored	78% (n=749/960)	88% (n=2674/3033)
8	Compliance with antimicrobials as per policy (RTI, UTI, BSI)	Not Monitored	Not Monitored	UTI -97%(n=34/35) RTI-98%(n=45/46) BSI-97%(n=37/38)
9	Surgical prophylaxis	34% (n=164/480)	71% (n=803/1130)	87% (n=1533/1761)
	Outcome Metrics			
1	Total DDD/1000 Patient Days	Not Monitored	17509	17996
2	Total DDD/1000 Patient Days (Restricted antimicrobials)	Not Monitored	1087	852
3	Total DDD/1000 Patient Days (Limited access antimicrobials)	Not Monitored	3046	2938
4	Total DOT/1000 Patient Days	Not Monitored	904	987
5	Total DOT/1000 Patient Days (Restricted antimicrobials)	Not Monitored	480	353
6	DRI	Not Monitored	0.66	0.57

narrower spectrum empirical antibiotic for them becomes a challenge at times.

Slowly evolving culture of cultures: Some of our prescribers are yet to imbibe the culture of cultures and are either reluctant to send the appropriate cultures before starting antimicrobials or find this practice a waste of resources.

Expanding the team of antimicrobial pharmacists: A solo person can do only so much. Though our lead antimicrobial pharmacist has been a game changer for us, we find it difficult to add more hands and minds to this cadre.

Infection prevention and control training issues: Non-adherence to infection control (IC) practices due to sudden changes in the staff-patient ratio were the

other challenges that often led to setbacks in the program.

Despite these challenges, we have been able to make a significant headway in our program. Critical factors behind this have been multifactorial and multidimensional. Regarding surgical prophylaxis, the first and foremost factor was the commitment of a multidisciplinary core team to conceptualize, collect the evidence, and initiate this program. The presence of good literature was helpful, along with the fact that initiation for surgical prophylaxis was done for clean surgeries where the scope of other confounding variables was minimal. The consensus building amongst various surgical specialties towards writing our SP document ensured an excellent acceptance of the program in principle. Case-to-case addressing of individual concerns helped us overcome implementation challenges wherever they were encountered. Also, identifying a champion (Anaesthetist) was crucial to the success of the surgical prophylaxis vertical, as, in our experience, they are more in a position to make a difference in this aspect. Regular audits and feedback have been our key strategy. Discussing the feedback with the team and listening to their concerns and arguments helped the core team to rework their strategy. Collaboration amongst administration, infection control, engineering, and CSSD provided the collective confidence to stop the antimicrobials early on. Celebrating success with other teams encouraged and motivated others to join the initiative.

Similarly, regarding empirical prescription practices and de-escalation, the critical factor for success has been a multimodal and multidisciplinary approach to resolving the concerns in a participative and engaging manner. Perseverance, celebrating small gains, and returning to the drawing board to re-strategize during failures have ensured that we stay aligned with the program. The active involvement of lead antimicrobial pharmacists has been a crucial factor. Targeting the aspects of antimicrobial prescription by the pharmacist that do not impinge directly on the prescription domain of clinicians, like appropriate dose, route, and double spectrum combinations, ensured easy acceptance of the pharmacist's involvement in the initial phases. This led to a more incredible rapport and confidence to influence change in behavior and prescription practices as the program matured over the years.

Similarly, the non-binding suggestions the AMS team gave helped build an environment of trust amongst colleagues. Champions were the individuals who sometimes took a leap of faith to try and do things differently than the prevailing environment, especially seen with our surgical prophylaxis vertical. Their commitment and attention to meticulous record keeping ensured robust data availability for use towards change management. The support provided by the administrative control has been of immense help. The governance mechanism has ensured a continuum of accountability for the efforts across the board.

There have also been many setbacks and stalemates that required stepping back often, reenergizing the team, resetting the goals, defining measurables, and engaging peers for group discussions. Increased national and international conversations, guidance documents, and mandate of AMSP by accreditation programs like the National Accreditation Board for Hospitals (NABH) and Joint Commission International (JCI) have strengthened our AMS team to carry on their stewardship activities with renewed vigor.

As we enter the consolidation phase of our program, we intend to amalgamate antifungal stewardship in the ambit of our program. Our ultimate objective is to see AMSP get embedded into the cultural fabric of our organization, with self-stewardship becoming a way of life for all prescribers. We will then be able to celebrate penicillin's centenary on 28th September 2028 with the gusto it deserves. A journey of a thousand miles begins with a single step, and we have taken some significant steps in this AMSP journey of ours but still have miles to cover.

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CONFLICT OF INTERESTS STATEMENT

The authors declare no conflict of interest.

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ETHICS STATEMENT INCLUDING PATIENT CONSENT

Not applicable

AUTHORS' CONTRIBUTIONS

SCV: Conceptualisation, review and editing

AKM: Conceptualisation, writing the draft, review and editing

AS: Writing the draft, review and editing

PKC: Writing the draft, review and editing

SJ: Review and editing

PS: Review and editing

AK: Data curettage and compilation, review and editing

AI DECLARATION

No AI tool was used to generate research data, perform data analysis, interpret findings, formulate scientific conclusions, or make editorial decisions. All AI-assisted content was critically reviewed, verified, and revised by the authors. The authors take full responsibility for the accuracy, originality, integrity, and final content of the manuscript.

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