

Exploring the social ecology for appropriate antibiotic prescribing and stewardship in primary care: presenting the VALUE driven model of practice derived from qualitative analysis of public and private care settings in Singapore

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Abstract

Background: Singapore's healthcare system allows both antibiotic prescribing and dispensing across public and private primary care settings, presenting an ideal context to learn from systems where dispensing is closely tied to diverse operational models and funding mechanisms.

Aim: To explore processes underpinning decision-making for antibiotic prescribing by primary care doctors in Singapore, by examining doctors' experiences in different primary care settings.

Methods: Thirty semi-structured interviews were conducted with 17 doctors working in publicly funded primary care clinics (polyclinics) and 13 doctors working in private general practitioner (GP) clinics (solo, small group and large group practices). Interviews were audio-recorded and transcribed verbatim. Data were analysed using applied thematic analysis.

Results: Given the lack of National Guidelines for antibiotic prescribing in the Singapore context, this practice is currently non-standardised in both private and publicly funded primary care settings. Themes contributing to best practice narratives relate to having independent funding sources and control over drug formulary orders, and valuing reduction in antimicrobial resistance (AMR). The existence of trusting patient-doctor relationships, and reasonable patient loads were observed to allow joint participatory and informed decision-making that further enabled appropriate prescribing. The importance of monitoring and application of data/evaluations to inform practice was a minority theme, nevertheless underpinning all levels of optimal care delivery.

Conclusions: A model for appropriate antibiotic prescribing-related interventions needs to prioritise addressing and shaping organisational and personal *Valuing* of AMR reduction. These values have to also *Align* with wider systemic constraints experienced in publicly funded institutions, operational management of private clinics and interactions with patients at the interpersonal level. The overcoming of such constraints and allowing time for patient *Liaison* and trust building will crystallise these earlier initiatives. *Use* of data to monitor and *Evaluate* antibiotic prescribing, informing optimal delivery systems should be routinely shared for transparency and to improve prescribing practices. These dimensions are summarised in the **VALUE** model for appropriate antibiotic prescribing and stewardship in primary care, which is recommended as transferable to diverse contexts.

1. Introduction

Antimicrobial resistance (AMR) is a rising global health threat. It has been projected that 10 million annual deaths would be attributable to AMR by 2050, with nearly half of these occurring in Asia [1]. Traditionally, antibiotic stewardship guidelines have primarily focused on tertiary hospitals, while such recommendations remain lacking in outpatient settings [2–4]. In 2016, the US Centers for Disease Control and Prevention (CDC) released a guiding framework for antibiotic stewardship in outpatient settings, which included primary care clinics, to extend monitoring and improvement of antibiotic use in such contexts [5].

Antibiotic prescribing decisions among doctors are influenced by psychological, behavioural and social factors. The decision-making process which a doctor adopts on antibiotic use has been described as an adaptive expertise, which requires the incorporation of their knowledge, experience and cognitive styles, but also framed by the characteristics and complaints of the patient [6]. These decisions are also described as being made under varying levels of support, cognitive loading as well as consideration of how they are likely to impact the patient [6]. In addition, antibiotic prescribing by a primary care doctor has been found to be dependent on the doctor's presentation of 'expert self', 'benevolent self' and 'practical self' during the clinical consultation, and influenced by interaction with the patient and the context of clinical practice [7]. However, existing literature has mainly focused on direct influencers impacting the doctor's antibiotic prescribing decisions such as the lack of resources to guide clinical judgment, pressure due to diagnostic uncertainties and busy consultations, and patient demands and expectations, while the contributory role of the broader clinical practice environment on prescribing behaviours has been largely under-explored [8–17].

Given the increased awareness of viral infections amid the COVID-19 pandemic, doctors' clinical management and patients' health-seeking behaviours for treatment using antibiotics are likely to have been modified [18, 19]. More evidence-based theory-driven approaches are needed to guide antibiotic intervention development that accounts for systemic differences which are less affected by the volatility of external factors.

The distinct organisational structures, cutting across public- and private-sector primary care clinics in Singapore, present an opportunity to comprehensively study the role that operational models play in antibiotic prescribing.

In addition, there is a paucity of qualitative studies in countries where the doctor both prescribes and dispenses medications in the clinic [8–17, 20–25]. The current study contributes to this body of literature and aims at exploring transferable findings pertaining to the social ecology influencing antibiotic prescribing.

Primary care structures in Singapore

In Singapore, 20% of primary care attendances occur in publicly funded polyclinics, with the remainder in private general practitioner (GP) clinics [26]. GP clinics include 1) Solo practices, which are single clinics that operate under a registered clinic name, 2) Small group practices, which refer to group practices that operate 2 to 8 clinics, and 3) Large group practices, which operate more than 8 clinics. On average, 20 to 30 doctors practice concurrently at each polyclinic on each clinic day, compared to one to two doctors at each private GP clinic. In most solo and some small group GP practices, diagnostic tests are outsourced to third-party service providers incurring additional operating costs whilst medications are dispensed by the doctor with no or minimal pharmacist involvement [27].

Large group GP practices, on the other hand, have a central operating structure that governs how clinics within the practice are run. This centralization structure allows for operating cost-savings through successful negotiations of lower rental fees, and bulk purchases of diagnostic services and medications.

In contrast, polyclinics are multidisciplinary primary care clinics that provide a range of healthcare services including outpatient medical care, nursing, pharmacy, radiology and laboratory services. Out-of-pocket payments by patients are much lower at polyclinics than GP clinics, due to government subsidies and economies of scale [28].

Given the complexity of how primary care practices are organised in Singapore, this study aims to explore the mechanisms behind decision-making processes for antibiotic prescribing by primary care doctors in Singapore by examining the experiences of public- and private-sector doctors.

The study objectives are:

1. To explore core elements influencing antibiotic prescribing across public and private primary care settings;
2. To build a conceptual model explaining the social ecology of antibiotic prescribing across these settings.

2. Material And Methods

Study Design and Study Population

Semi-structured interviews were conducted with primary care doctors in publicly funded polyclinics and private GP clinics between June 2018 and January 2020. In Singapore, there are 20 polyclinics and up to 2222 private GP clinics, serving a population of 5.7 million people [29]. To achieve maximum variation, the study participants were purposively recruited from four different settings: polyclinics, solo GP practices, small group GP practices and large group GP practices, with a good mix of age and years of practice in their current practice setting [30]. Locum doctors were excluded from the study. In addition to this maximum variation sampling strategy, the sample size required for this study was also grounded in the principles of data saturation. The study was conducted and reported according to the Consolidated Criteria for Reporting Qualitative Research (COREQ) guidelines [31].

Semi-structured Interviews

A semi-structured interview guide was developed by HG (Female, MPH, Research Fellow) based on current literature and thereafter used to explore the factors influencing antibiotic prescribing practices among polyclinic and GP doctors in the primary care clinics. The topics and related questions included the clinical and non-clinical factors that influenced participants' prescribing practices at the individual, interpersonal, organisational, and community levels [32]. Studying the experiences and practices at these socio-ecological levels would enhance researchers' understanding of the complexity of antibiotic prescribing processes.

Pilot interviews were conducted by HG with three primary care doctors to ensure content validity and the proper phrasing of questions in the guide. HG and another study team member (Female, MPH, Research Assistant), who were public health researchers trained in qualitative fieldwork, conducted the interviews.

Interviews were also cross-audited by both study team members by observing three interviews respectively. The audit was undertaken to minimise interviewer bias, provide feedback on interview techniques as well as to ensure adequate probing and rapport building throughout the interview process.

The participants were first approached via email or text messages where they were provided with the participant information sheet. Informed consent was taken onsite on the day of the interview. Each interview lasted for 45 to 60 minutes. Interviews were conducted at a preferred time and location specified by the participant to provide the greatest convenience and ease for the interview. Confidentiality was ensured by conducting the interviews behind closed doors at the respective doctors' clinics or in a quiet corner in a public location. Interviews were conducted after consultation hours and in the absence of clinic staff from their respective clinics.

Moreover, no personal identifiers were collected, and participants were assigned a study identification number that was used throughout the study duration. Before the commencement of each interview, the interviewers would introduce themselves as researchers with no prior medical knowledge to ensure that participants could be candid and forthcoming with their responses. Every session was audio-recorded and transcribed verbatim.

Data Analysis

Data were analysed using an applied thematic approach [33]. Two coders first familiarised themselves with the interview data, which were organised according to selected levels derived from the social ecological perspective. Specifically, the coders compared the narratives of antibiotic prescribing practices between doctors from publicly and privately funded primary care settings. This in-depth familiarisation process informed the development of a preliminary codebook. The coders subsequently coded the transcripts independently and met to discuss their coding. New codes were added iteratively to the codebook as analysis continued. Discrepancies were discussed and resolved in the presence of a third study team member. Both intercoder agreement and saturation of broad codes was achieved after coding five transcripts [33]. The agreed codebook was subsequently applied to the rest of the dataset before data reduction and summarisation were undertaken during the final stages of the analysis. Data were organised and coded in MS Word. Basic descriptive data of the participants was computed using STATA/SE 15.0 (StataCorp LLC, College Station, TX).

3. Results

Study Participants

Thirty primary care doctors were interviewed. Their median age was 40 (range 27 – 69) years (Table 1). The majority were Singapore citizens and of Chinese ethnicity. There were more female participants represented in the polyclinics than GP clinics. In contrast, more participants from GP clinics had more than 10 years of clinical experience, and more had post-graduate training in Family Medicine than those from the polyclinics.

(1) Exploring core elements influencing antibiotic prescribing across primary care settings

National antibiotic prescribing guidelines

In relation to the broader Singapore context, polyclinic doctors shared that they could refer to the paediatric dosing and disease-specific treatment guidelines made available to them by the polyclinics for antibiotic prescribing while these were generally absent in the GP settings, regardless of practice size. The lack of standardised national antibiotic prescribing guidelines in primary care meant that doctors often had to rely on multiple out-of-context sources (such as hospital and/or non-local guidelines) to inform their prescribing decisions:

"In Singapore, I don't think we have such a guideline. There's a need for this, but we don't have [it]...Every single hospital, they have guidelines for antibiotics...we can follow [that]." (GP23)

"I rely more on Up-To-Date actually." (P5)

Nonetheless, it was unanimous amongst polyclinic and GP doctors that guidelines could only provide guidance, while antibiotic prescribing decisions should be predominantly based on their personal clinical judgment of the patient's medical condition:

"I mean to be honest, even for the treatment guidelines, as much as it can be followed, a lot of times there are a lot of grey area[s]...Because every patient is different. In that sense, guidelines are only meant to guide us in a certain way but we still need our clinical discretion to decide whether truly the patient needs antibiotics or not." (P5)

However, such guidance would also set the backdrop for clear shared organisational values at the national level and provide a concrete starting point for aligning practices across primary care settings.

Operational models of primary care

Primary care in Singapore is provided through two different avenues: public polyclinics and private GP clinics, and patients are free to choose their preferred primary healthcare provider [27]. Family practice or family medicine is characterised by the provision of holistic care ranging from acute episodic care to the prevention and management of long-term conditions to patients and their family members, in the community:

"For family practice to be able to continue and grow, acute care is not the main thing they have to focus on. Actually many times we actually look at the complete care...not just disease management...we are actually moving towards health prevention and disease prevention and...the next stage...health preservation, means how to actually make them healthier and better as a whole family, [and] not just the patient [alone]." (GP12)

However, the way how a primary care clinic operates deeply influenced the manner doctors established themselves as primary care practitioners in Singapore and therefore the values they have for patient care.

In some situations, doctors viewed themselves as service providers for the patients and thought it is important to ensure patient satisfaction. Hence, they voiced that their prescribing of antibiotics might be the result of giving in to patient demands rather than their clinical judgment:

"Healthcare has unfortunately become very customer service-oriented...after thoroughly counselling the patient...for indication, as opposed to having the patient scream at you...I may give Amoxicillin...it's a fine line to tread between getting a complaint and exercising your best clinical judgment." (P1)

" We still partially belong to the service sector you know, so a lot of times I do have to admit that if patients ask for antibiotics and they are insistent, our threshold to reject them is very low." (GP22)

Primary care doctors are vulnerable to medical liabilities, but by practising under a larger clinic with a publicly funded operational model, such as the polyclinic setting, it gave the doctors a sense of security due to perceived organisational backing. This was said to contribute to relieving the pressure of having to satisfy patient demands:

"When you are working in polyclinic[s], you have [the] government on your back...but in the private sector, the issue is when...medical legal [issues arise]...or patient come after you with a lawyer letter...when things happen, their backs are not covered." (GP30)

"Practising here in the polyclinic gives me the liberty of not giving antibiotics unless its evidence-based and that, to a certain extent, gives me empowerment...not forced to give anything just to make the patient happy. So it's easier to practice that way...you don't have to bow to the wishes of the patient but you practice the way you are supposed to." (P9)

By practising in different contexts, primary care doctors were influenced by different broad fundamental values of care delivery underpinning the operational model of their clinics.

Financial considerations

The operational model of the clinics determines how finances are considered and provided for patient care. In polyclinics, consultation fees are subsidised by the government for all local residents. Polyclinic doctors shared that patient health financing schemes, insurance and claiming considerations had little or no influence on antibiotic prescribing habits since government-subsidy is provided to the majority of their patients:

"It doesn't really matter for me because I feel that everyone is [given] subsidised care [by the government]...if I feel that antibiotic is really needed, I will give the antibiotic. It doesn't matter." (P20)

However, the situation in the GP clinics was much more complex due to the participation of third-party administrators (TPAs) or managed care organisations (MCOs) acting as middlemen to provide affordable care to employees of subscribing companies and sustainable patient referrals to participating GP clinics [34]. The opinions of solo and small group GPs towards TPAs or MCOs were mixed. Whilst

some welcomed their presence in sustaining patient pool, others disfavoured TPA or MCO's involvement as they found that the contract restrictions impacted clinical practice and related antibiotic prescribing:

"I don't do company contracts [referring to TPA and MCO contracts] but I [have] work[ed] in company contract clinics before. So for example, you get antibiotics right, you give 5 days or 7 days. At the counter, the staff will cut down to 2 or 3 days because to cut costs... That's why I don't do contracts... they only give you this amount. So you either hit it or you bust it." (GP14)

"We used to take up some of the third party insurance companies [referring to TPA and MCO contracts] and they will restrict you to prescribing generic rather than patented. But not the decision to prescribe or not to prescribe... For those who accept the insurance payments, the insurance company's terms and conditions can be very restrictive... I think it affects one's prescribing habits." (GP25)

Furthermore, GP doctors felt that TPA and MCO contracts disrupt the patient-doctor relationship by turning it into transactional cost-based relationships which lacked mutual trust or respect, especially when the patient-doctor relationship was highly valued by GP doctors (to be illustrated below). Patients were mainly referred by the third-party administrators engaged by their companies at a subsidised rate and doctors thought that these patients lacked loyalty to a specific healthcare provider:

"For those [under TPA/MCO] contract... there is no loyalty, there is no trust... there is no mutual trust or respect... So sometimes if you just want to get rid of the patient, you just give [antibiotics]." (GP14)

"Because the relationship you have with patients with managed healthcare [refers to TPA/MCO]... the patients already have a conception that you're not going to treat them well... because they have the card. They can just go to another GP the next day [and] just pay 5 dollars." (GP24)

As compared to polyclinics, financial considerations had more influence within the GP settings and the participation of third-party administrators disrupted the relationship between doctors and patients, and subsequently changing antibiotic prescribing practices of GP doctors.

Drug formulary management

Primary care clinics in Singapore both prescribe and dispense medications to patients at a single location and their operational models also determine the way drug formulary is managed in each clinic. The pharmacies within the polyclinics are managed by outpatient pharmacists and the drug formulary is controlled by the organisation. Polyclinic doctors mentioned that they hardly made decisions on antibiotic procurement for the formulary and they could divert their patients to collect antibiotic prescriptions from community or hospital pharmacies if the drug was not stocked up in the polyclinics:

"There were some cases whereby a patient... [has] multiple allergies to different antibiotics and then the one that I wanted to give wasn't available. Levofloxacin. So in that case I give him an external prescription that he can buy... in the other pharmacies." (P6)

In the GP settings, drug formulary management forms a large proportion of the GP doctors' role in clinical practice. These doctors expressed that they had the autonomy to customise their formulary, purchase and prescribe preferred antibiotics to their patients, and had the autonomy to shape prescribing norms within their clinics:

"I own my practice...I can put very fanciful stuff...I mean we can order in. Private practice is very simple. You want something, it comes in 2 days. You don't need a process of [procurement]. So it's actually extremely minimal and efficient." (GP15)

"I have, over the years, kind of narrowed down my antibiotics to those that I most likely would use...I think I have almost never written a prescription outside for antibiotics." (GP24)

"Before I start work anywhere, I will look at the stocks and see whether my favorite medicines are available or not. If they are not, I will ask for the medications to be brought in." (GP27)

However, a couple of solo GP doctors felt that drug formulary management distracted from what they felt was their professional duty to focus more on clinical consultation and less on administrative concerns that arise from having to procure and dispense medications:

"We're more than happy to lose the pharmacy actually...we have to manage the dispensary, to manage all these medication, [but] to us, this is not our core job right? Our core job is a doctor...to provide consultation and just charge the consultation...we can actually focus what is important to us." (GP23)

"I have no problems with [abolishing dispensing role]. It reduces my headaches. I just put a consult fee and that's it. I don't need to buy drugs, and think about what tier I have, how many shall I stock, can I dispense it before the drug expires." (GP24)

Primary care doctors not involved in managing the drug formulary could exchange the required time and effort for better focus on their clinical duties in consulting patients.

Values and aligning these to clinical delivery

Owing to the differences of how their clinics operate, primary care doctors deliver care differently with variable sets of values for patient care. While solo and small group GP doctors bore more responsibilities to ensure business sustainability of their clinics, in large group GP clinics, they experienced greater autonomy and flexibility in aligning their practices in accordance to their personal values. They could often strike a balance between business concerns and freedom to practice their personal values on care delivery, and this included decisions on prudent use of antibiotics:

"We charge very high for consultations...I do not need to sell antibiotics to earn money. I do not need to sell medicine to earn money...I can talk the whole half an hour with you and I charge 100 bucks. I don't even need to...sell you anything. So that is the beauty of it. I am not pressured to give you antibiotics or for that matter, any medicine." (GP14)

"In our practice we have a lot of control because basically we run our own practice...so basically we're not obliged to follow what the patient wants. We are quite happy to lose the patient because we are so busy anyway. So we are not obliged to give whatever the patient requests for." (GP23)

Nonetheless, a couple of GP doctors shared how this could be a double-edged sword. Sometimes the pressure to sustain business could drive GP doctors towards prescribing antibiotics in order to increase earnings:

"The principle behind every GP's prescribing practice is different. I know that there are some more profit-driven GPs, whom I think would give antibiotics because of higher profit margins." (GP28)

"I am sure there is financial pressure for doctors to add antibiotics...they may not disclose this. Because who will say that, "Oh I give medicine because it's additional revenue but not because it's indicated?" (GP29)

In larger organisations like polyclinics or large group GP clinics, organisational values and related practice norms within the clinic had significant influence over the doctors' decision to prescribe antibiotics for their patients, over and above the doctors' personal values and preferred practices:

"A lot of times, it's a legacy effect as well because for us, we belong to an organisation. So the clinic changes hands very frequently and usually when we come in, we inherit what was given to us. We make minor changes along the way but a lot of times we keep to what was given to us." (GP22)

"We are more resource-strapped and we have more protocols, I feel that we are a bit more restricted when it comes to giving antibiotics." (P20)

"In a small place like us...you stick out...whatever thing you do will stick out...another doctor will pick up and...instant reporting...so that helps [to] keep us on our toe[s]...Whereas...if you are [in] solo [practice], it's different. There's nobody to police you...at least here...we will think...how would your peer[s] think...[and] what repercussion." (P11)

As such, organisational values (or personal values) and their related norms are impactful on influencing clinical practice and antibiotic prescribing by individual primary care doctors.

Liaison with patients and joint decision-making

Organisational and personal values influenced the ability to make joint decisions with patients on antibiotic prescribing. But both the clinics and individual doctors need to value active patient liaison alongside patient care. Continuity of care with a longitudinal patient-doctor relationship also enabled successful joint decision-making processes:

"It is always important in family medicine that we establish a very close and long relationship with your patient. And a correct relationship is always a partnership. So when you have established a partnership, that means there is a great degree of trust and communication channels are naturally opened. So once

that happens, it is very easy to be able to come up with a management plan that both agree on. And usually the patients would listen to the doctor.” (GP13)

In addition, being explicit about appropriate antibiotic use in primary care according to national antibiotic prescribing guidelines will both serve to enable patient liaison and align communication between polyclinic and GP doctors.

Trusting patient-doctor relationship

Successful patient liaison was expressed as having invested in building trusting patient-doctor relationships. These were highly valued by primary care doctors, and were seen to create better communication and care delivery:

“A good patient-doctor rapport will solve a lot of issues. One is trust, two is the willingness to work out problems together and solve it versus one who have no rapport where you are just there to ‘service’ the patients...[The patients] will treat you like a technician...but then again, rapport takes two hands to clap. So it is not just willing doctors but also the patient has to be willing to establish that. So overall, if there is cooperation, a lot of things tend to work out better, of course.” (GP30)

Polyclinic doctors shared that it was difficult to build a trusting patient-doctor relationship. In these settings, organisational practice and norms often meant both high patient load and discontinuity of attending doctors with regular patients. For example, the registration system randomly assigns patients to an attending doctor. In addition, the regular rotation of doctors between the different care sections, for example acute walk-in section, chronic care and paediatric sections impeded the doctors from seeing the continuity of regularly treating their own patients:

“I mean usually [in the] polyclinic, there are a lot of patients. So our rapport is not as easy, I think. And we don't usually see our own patients back. So maybe it's not as easy for them to trust us.” (P4)

This experience was different for many GPs. Due to the autonomy and flexibility in shaping their practices in accordance to their personal values, solo and small group GP doctors expressed that they were able to structure their model of care to be conducive for the establishment of a trusting patient-doctor relationship. This happened, in part, through referrals and easy to use appointment systems ensuring continuity of care:

“We have been around for a while and also our model of care is very different. So we go by appointment system. We do very little walk-in and a lot of people know us. They are referred by friends and all that. So after a while, the trust level is very high.” (GP14)

“We will keep out these doctor hoppers, because we have an appointment system... So those patients that are used to seeing us, they will book online and they have to pay five dollars to actually see us...once patients know that we practice in this way, and is very clinically based...they are very happy to come and... they are willing to pay.” (GP23)

By influencing patient selection and consistency of care, GP doctors mentioned that it was easier to counsel patients on prudent antibiotics use:

"I do have a very matured practice, so I do understand where you're coming from, whereby some patient[s] who say "Because you don't give me antibiotics, you're a lousy doctor, I'm not seeing you anymore, I go elsewhere". So I actually do not have this problem...I would explain to the patients. And I do ask them, I don't think you need antibiotics right now. You may later but you do not know, but if you can it's always better to avoid it, are you ok with it?...So usually [we are] able to come to a consensus." (GP13)

"My patients are very well-selected...because over the years, you sort of train[ed] them not to use antibiotics...because we do have a reputation that we don't give antibiotics, so generally after a while, all those in the neighborhood [who] wants antibiotic...will not turn up in our clinic...it's the training." (GP14)

In such circumstances and in particular, in mature practices, doctors were able to align their personal values with patient care.

High patient loads

On the other hand, high patient loads were said to impede joint decision-making and contributed to suboptimal antibiotic prescribing decisions. The lack of time and likelihood of being able to see the same doctor, and take time to counsel and build trust were the traded-off to deal with the volume of patients:

"Yeah, that...does play a factor. So let's say if there [are] time constraints, sometimes I don't have the luxury of time to explain in detail...So definitely...it will lead to more antibiotic prescription[s]...because we don't have the time to explain in detail...so we end[ed] up giving more to those who insist[ed]." (P6)

"On days whereby I am superbly busy...sometimes you have to see like 80, 90 patients in a day, and if the patients request for antibiotics and you don't have time...I guess if it's so clear-cut that he needs it, I would just prescribe." (GP13)

In contrast, with the autonomy to control their patient flow, GPs in particular talked about ensuring that they spent sufficient consultation time to counsel each patient:

"Another thing that we build in our practice [is that] we give time [to our patients]...[for] every patient, we schedule 10 minutes. So now we are quite happy that we have an appointment system." (GP23)

These differences drove normative antibiotic prescribing practices which is explained by the balance required by primary care doctors to manage time for patient care and to spend time in building trust and explaining to patients why antibiotics were not needed when not indicated.

Use of data to monitor and evaluate

While audits were thought to be useful to improve antibiotic prescribing habits, primary care doctors expressed that more could be done. In the polyclinics, regular audits were at times described as part of the organisational process for monitoring antibiotic prescribing, although these procedures were not often notable in practice:

“So for us in the polyclinic...we do have check and balances on how we order our antibiotics.” (P19)

“I think polyclinics do audits on the antibiotics prescribing right? I think, I’m not that sure.” (P3)

Similarly, in GP clinics, while random audits by the Ministry of Health were said to take place, antibiotic prescribing volumes were not queried during this process meaning that little external pressure to reduce antibiotic prescription was being routinely applied and tracked:

“We have audits...I mean MOH does come down and audit our medical records...They do look through medical records but they don’t go and count how many antibiotics you have used.” (GP30)

To enable successful antibiotic stewardship in the primary care setting, applied research should be conducted to provide a transparent platform for the formal use of monitoring and evaluation data to develop evidence-based guidelines:

“There should be an audit in every healthcare system whether it is a polyclinic, or a GP..Because we cannot be in every consult room every single time, so the only way to do is...to retrospectively audit the amount of cases where doctors are in a controlled environment like ours. In the polyclinic, it is very easy to do. I don’t know how feasible it is to do in the private practice but there should be some form of monitoring of this...you want to see whether in those situations, it was warranted for; and then the other thing is you can get patient’s feedback. I mean if there are more studies or surveys tracking patients in the private and polyclinic healthcare then we have a better idea of whether [antibiotic use] is really effective...or not in our population.” (P20)

By having better transparency and formation of feedback loops, active evaluation and improvement on antibiotic prescribing in the primary care clinics can be more effective.

(2) Building a conceptual model of antibiotic prescribing across primary care clinics

Based on the above themes, we propose the **VALUE** model to conceptualise the key components for appropriate antibiotic prescribing and stewardship in the primary care (Figure 1).

Firstly, it is critical to capture the national context upon which the primary care system is built. In the Singapore context, a notable gap related to the absence of updated national antibiotic prescribing guidelines, with appropriate prescribing clearly defined, was identified. Such guidelines can be leveraged to drive the internal mechanisms including organisational and personal *Values* which were said to play a pivotal role in reducing inappropriate prescribing of antibiotics. Shared values on appropriate prescribing need to be *Aligned* with the underlying operational mechanics of clinical practice, such that overcoming

systemic constraints – for example management of high patient loads – that can occur in tandem. Relatedly, making time for patient *Liaison* and trust building with patients at the interpersonal level was found to be central to making joint decisions on antibiotic prescribing. Lastly, an active feedback loop should be established to *Use* data for monitoring and to produce *Evaluation* reports. By sharing data and research findings on appropriate antibiotic prescribing, as defined by national guidelines, procedures can be transparently tracked and outcomes improved.

The VALUE model is recommended as transferable to diverse contexts, either to bridge potential private-public sector gaps, for quality enhancement in either setting, or to inform performance monitoring and realist evaluations.

4. Discussion

Our study has identified themes that lend critical insights on antibiotic prescribing by primary care doctors and shed light on the underlying mechanisms driving antibiotic prescribing across primary care settings. Themes relating to the operational models used in clinics, financial considerations, drug formulary management, patient load, and a trusting patient-doctor relationship, were demonstrated as central to appropriate antibiotic prescribing.

The importance of such elements have been highlighted elsewhere [7]. For example, both the importance of established and up-to-date national antibiotics guidelines [24] and that of valuing patient-centered care have been demonstrated to contribute to reducing antibiotic prescriptions [35]. In addition, the role of the interpersonal level is known to affect antibiotic prescribing, in particular when doctors do not take time to accurately assess patients' expectations of antibiotic prescription [36]. Further to which it is notable that being given antibiotics does not always correlate with satisfaction of the clinical encounter anyway [36, 37]. As for use of monitoring and evaluation data, this has long been recommended for practice improvement by the US CDC guidelines and recently, by Arieti *et al* [5, 38].

Nevertheless, there remains a powerful need to 'connect the dots' by providing a realist [39], applied and evidence-based conceptual model that maps the social ecology and potential areas for intervention to improve appropriate antibiotic prescribing. A recent study conducted in Sweden found that doctors in private practice were 6% more likely to prescribe antibiotics as compared to doctors in public practice [40], with a similar trend observed from another cross-sectional study conducted in Malaysia [41]. Instead of dissecting and addressing the issue of inappropriate antibiotic prescribing by different primary care funding structures, the current study offers a comprehensive exploration across private and public sectors. Outlining not simply the elements driving appropriate and inappropriate practice but how these interrelate.

Collective and coordinated antibiotic stewardship efforts in primary care (both public and private practice) would improve appropriate antibiotic prescribing in primary care clinics at a national level [42]. Our study highlighted opportunities for national interventions to improve antibiotic prescribing in primary care, particularly in private practices which manages the bulk of primary care acute conditions in

Singapore. We observed that primary care doctors desired national guidelines on antibiotic prescribing to standardise best practices. Guidelines based on local epidemiological data and antibiotic susceptibility patterns would be crucial for supporting primary care antibiotic stewardship and overcoming variations in context- and values-based prescribing practices. Clinical decision support tools can also play a role in guiding primary care doctors in evidence-based antibiotic prescribing decisions by developing risk prediction models to guide antibiotic prescribing decisions, as demonstrated in a local outpatient emergency department setting [43].

The primary strength of the current study lies in the construction of the VALUE model and its transferability to other primary care contexts. The conceptual model can be cohesively applied to evaluate each level of the ecosystem to address inappropriate antibiotic prescribing. For instance, the VALUE model can be used to assess organisational culture, personal motivations, to critique and overhaul operations while accounting for funding structures, and helping to refocus where and how time is spent when battling high patient loads. The study also undertook one-on-one semi-structured interviews with doctors in primary care settings which allowed an in-depth exploration of antibiotic prescribing practices among this unique group of healthcare workers. Moreover, the researchers were careful in building rapport with study participants, which enabled them to be forthcoming and open in sharing their practices and experiences. Additionally, the use of a maximum variation purposive sampling strategy enabled the study to elicit the broadest range of experiences within our sample of interest. The study also utilized principles of data saturation and intercoder agreement to ensure the rigour and trustworthiness of the study findings.

We acknowledge that our data is however limited to a context and primary care practice that were pre-COVID-19. Rapid shifts may be on their way to influence the ecology of acute respiratory tract infections in the last 12 months.

Conclusion

Multiple factors influence antibiotic prescribing in primary care. The ability to make joint decisions with patients on antibiotic prescribing is dependent on the balance between managing patient load and building trusting patient-doctor relationships. Systemic constraints and hindered interpersonal interactions with patients can be overcome by aligning values on reducing AMR and promoting patient liaison through national guidance. Antibiotic stewardship interventions would only be effective if monitoring and evaluation data are used and shared with transparency to allow collective stewardship efforts on appropriate antibiotic prescribing in the presence of clearly-defined national prescribing guidelines.

List Of Abbreviations

AMR Antimicrobial resistance

CDC	Centers for Disease Control and Prevention
GP	General practitioner
MCO	Managed care organisations
TPA	Third-party administrator

Declarations

Ethics approval and consent to participate

Ethical approval for this study was obtained from the National Healthcare Group Domain Specific Review Board, Singapore (2017/01179) and all participants had consented to participate in the study.

Consent for publication

Not applicable.

Competing interests

All the authors declare no competing interests.

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Authors' Contributions

AC conceived the study, provided overall direction and planning for the study, and critically revised the manuscript. HG designed the interview guide, arranged and conducted the interviews, coded and analysed the data, and drafted the manuscript. ZJH provided guidance on data analysis and critically revised the manuscript contributing to the formulation of the VALUE model. VWKL, MS and WET provided guidance on the design of the interview guide, assisted the study team in inviting primary care doctors to participate in the study, and provided inputs for the manuscript. MABI assisted in the coding and analysis of the data, and provided inputs for the manuscript.

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Table

Table 1: Basic Characteristics of Participants

Demographics	Polyclinics	GP Clinics	Total
Number of Participants	17	13	30
Age, in years			
Median Age	35	47	40
Age Range	27 - 69	31 - 60	27 - 69
Gender (%)			
Female	13 (76)	5 (38)	18 (60)
Ethnic Group (%)			
Chinese	14 (82)	11 (85)	25 (83)
Resident Status (%)			
Singapore Citizen	15 (88)	13 (100)	28 (93)
Singapore Permanent Resident	2 (12)	0	2 (7)
Highest Education Level (%)			
Basic Medical Degree	10 (59)	5 (38)	15 (50)
Post-Graduate Degree in Family Medicine	7 (41)	8 (62)	15 (50)
Total Duration in Medical Practice			
More than 10 years, in counts (%)	7 (41)	9 (69)	16 (53)
Total Duration in Current Practice			
More than 10 years, in counts (%)	7 (41)	7 (54)	14 (47)

Figures

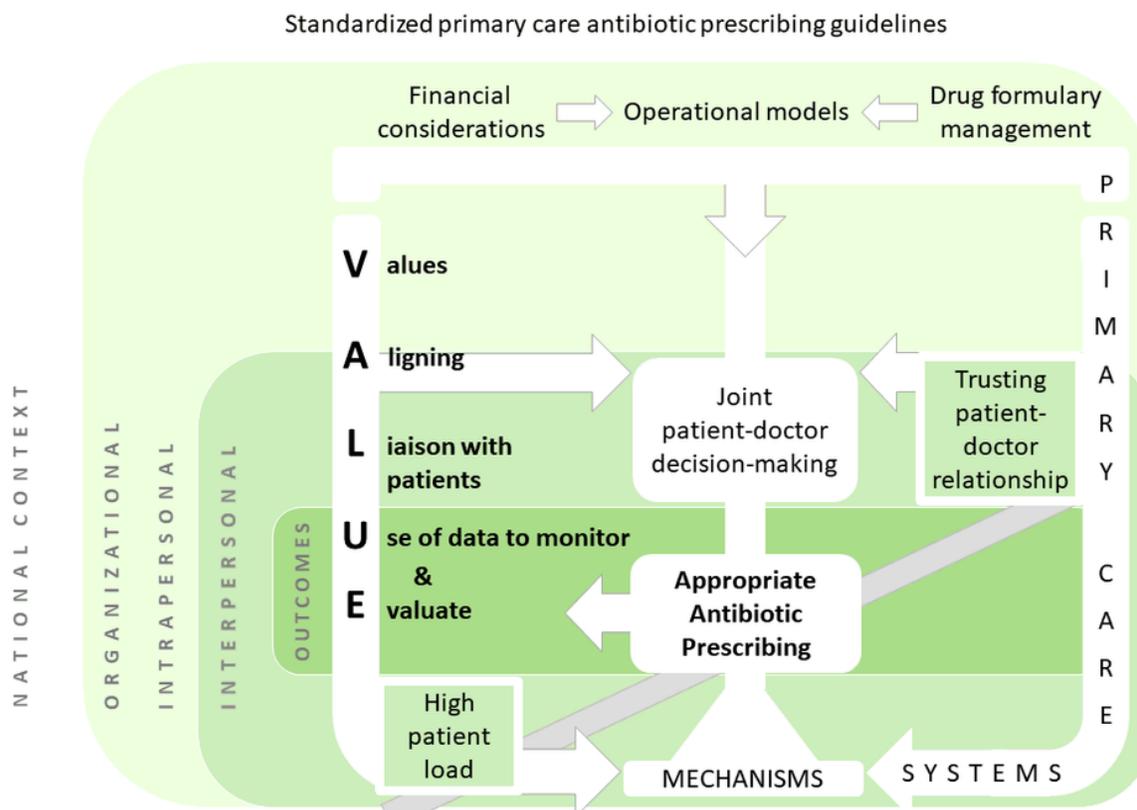


Figure 1

VALUE model for improving appropriate antibiotic prescribing