WHY STOP? Quantifying Cognitive-Behavioural factors that influence the impact of PCR-POCT results on antibiotic cessation in ICU

Suveer Singh (✉ suveer.singh@imperial.ac.uk)  
Imperial College London

Martine Nurek  
Imperial College London

Sonia Mason  
Guy's and St Thomas' Hospital NHS Foundation Trust

Luke Moore  
Chelsea and Westminster Hospital NHS Foundation Trust

Nabeela Mughal  
Chelsea and Westminster Hospital NHS Foundation Trust

Marcela Vizcaychipi  
Chelsea and Westminster Hospital NHS Foundation Trust

WHY STOP Consortium

Article

Keywords:

Posted Date: August 17th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1932248/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License
Abstract

**INTRODUCTION:** Rapid Point of Care Tests for infection (POCT) do not consistently improve antibiotic stewardship (ASP) of suspected ICU infection. We measured 1) the effect of a negative PCR-POCT on antibiotic stop decisions, and 2) clinico-behavioural factors that prevent stopping.

**METHODS:** Vignettes of antibiotic treated respiratory infection, with 4 distinct trajectories were presented to ICU clinicians: overall improvement, clinical improvement/biological worsening, clinical worsening/biological improvement, overall worsening. Initial and post PCR-POCT antibiotic decisions (stop or continue) /confidence levels were recorded. The PCR-POCT offer was voluntary but always presented and negative. Linear regression determined association of their final decision with influencing factors.

**RESULTS:** Seventy clinicians responded. A negative PCR-POCT increased stop decisions in all scenarios ($p<0.001$) except *improvement* (already high); especially in *discordant clin worse* (49% pre-POCT vs 74% post-POCT). Inclination to stop was reduced by an ambiguous/worsening trajectory ($p=0.015$), initial confidence to continue ($p<0.001$), and involuntary receipt of POCT ($p<0.001$), not clinician experience or risk averseness.

**CONCLUSIONS:** Negative PCR-POCT increases the inclination to stop antibiotics, particularly in ambiguous/worsening trajectories of ICU infection. Clinician intuition to continue and disinterest in POCT reduce its influence to stop. Highlighting and quantifying the predictive impact of behavioural-trajectorial factors can improve antibiotic stewardship and study design in ICU related infection.

What Questions Does This Study Ask?

1. *What effect does a negative POCT have on antibiotic stop decisions?*
2. *Why do clinicians not stop antibiotics when POCT data suggests that they can?*
3. *How is the inclination to stop influenced by clinical trajectory, clinician intuition, belief in POCT and clinician characteristics; experience and attitudes towards risk?*

Introduction

Antimicrobial resistance is a global emergency. A crisis of uncontrollable infection has been predicted [1]. That said, prescribing decisions in critically ill patients with nosocomial infection are often subject to diagnostic uncertainty; with the risk of negative consequences of under/over-treatment [2]. Antibiotic stewardship (ASP) is utilised as a strategy to improve appropriate prescribing; sometimes successfully implemented at the organisational hospital level [3]. The intensive care unit (ICU) is an important setting for such ASPs. Not only is there a high burden of antimicrobial use [4], but the illness severity naturally dictates a tendency to longer courses. Despite this, ASP driven reductions in antibiotic duration have not shown association with worse in-hospital mortality [3]. The use of biomarker surrogates of infection such
as procalcitonin (added to the conventional markers of white blood cell count and c-reactive protein) may be successful in reducing unnecessary antibiotic course lengths, in some controlled studies [5]. Yet, at a patient-clinician level, there is more uncertainty about the benefits of these strategies. Evidence exists regarding the benefits of certain ASP strategies such as frequent microbiologist input at ward rounds [6]. Other factors are likely important such as an organisational culture (i.e. restriction and enablement) and prescribing guidelines [3]. However, autonomous individual decision making is variable, often widely so amongst clinicians. Indeed the same clinician may have a different judgement in a similar scenario at different timepoints.

Unwanted variability in decision making has been termed ‘noise’ [7]. Various sources of noise can influence antibiotic stop decisions, including system noise (e.g. organisational variability, case mix, prevalence of infection/resistance, prescribing policies), pattern level noise (i.e. inter-clinician variation due to risk aversion, experience), and occasion noise (intra-clinician variability). Guidelines and protocols can reduce system level noise, but less so inter/intra clinician variability [7].

Point of Care tests (POCT), utilising molecular platforms such as polymerase chain reaction (PCR) [8], are emerging as a potentially valuable tool in rapid diagnostics. They have been an important strategy during the COVID-19 pandemic for identification of infection by SARS-CoV-2 [9].

Notably, POCTs for rapid diagnosis or exclusion of infection may be indirect biomarkers (e.g surrogates of the inflammatory effect of an infectious agent, i.e. IL1, IL8) or they may directly identify an infective agent (i.e. 16s or 23s ribosomes, PCR or RT-PCR) [10, 11]. Here, we refer to the second (i.e. infection-identifying POCT), for which a number of commercially available PCR molecular platforms are in use mainly to determine the presence of infective organisms.

In the context of bacterial infection, POCTs have been treated more as an antibiotic start/stop trigger, where other indicators of infection may be less certain. Specifically, in suspected ventilator associated pneumonia (VAP), studies using biomarker combinations such as IL1/8 are highly accurate in ruling out respiratory infection [12]. Yet this efficacious ‘rule out’ test has not led to more antibiotic free days [13]. Thus, the utility of POCT in decision making strategies to reduce antibiotic prescribing has not been demonstrable [13]. Their effect may be diminished by competing factors (cognitive, behavioural and/or situational), producing unwanted variation in judgements. These probably override clinical information available at the time of the antibiotic stop decision. Yet, little research has been performed to identify, quantify and modify these factors [14].

So, we sought to understand what factors, and to what extent they influence clinicians’ antibiotic stop decision making when presented with scenarios of common ICU related respiratory infection and varying degrees of apparent uncertainty. The focus on stopping antibiotics was because the threshold for resolution of an infection is poorly defined. This uncertainty may lead to variability in the decision to stop antibiotics. With this in mind, we sought to:
A. measure and quantify the effect of negative POCT results on antibiotic stop decisions, in situations of uncertainty for resolving infection;
B. identify factors that might “compete” with negative POCT results and prevent stopping;
C. explore the effect of defined clinician characteristics on antibiotic stop decision making.

We expected that a negative POCT result would increase stop decisions (hypothesis 1), while the following factors would reduce it: an ambiguous/worsening clinico-biological trajectory (hypothesis 2), clinicians’ first impressions (specifically, high confidence that antibiotics are needed, hypothesis 3), and disinterest in POCT (rejection of the test, when offered, hypothesis 4). We also expected that less experienced clinicians would be less inclined to stop (due to lower confidence, hypothesis 5), as would those higher in risk averseness (hypothesis 6). Further details are available in the Supplementary Materials (SM1).

**Methods**

**Participants**

Consultants and trainees in Intensive Care Medicine (ICM; 3 + months continuous experience in ICU) currently working in UK-based university teaching hospitals were invited to take part. informed consent was obtained for study participation

Participants completed an online survey, between May–September 2021.

**Materials**

Four simulated vignettes depicting ICU patients with respiratory infection were presented. Each vignette used clinical and biological data (i.e. WBC, CRP) to describe the patient’s trajectory after a course of antibiotics (Table 1). The full scenarios can be found in the Supplementary Materials (SM2).
Table 1

The four clinical vignettes used in this study The scenarios were constructed following an iterative process of piloting and revision. Pilot participants (colleagues) were not eligible to participate in the study proper. Further details of the piloting process are provided in SM4.

<table>
<thead>
<tr>
<th>Vignette name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improvement</td>
<td>A post operative case of a 66 year old man with bilateral pneumonia. Clinico-biological improvement after a 5-day course of antibiotics.</td>
</tr>
<tr>
<td>Worsening</td>
<td>A 65 year old woman with lobar pneumonia who deteriorates to requiring mechanical ventilation. After initial stabilisation after 4 days of antibiotics, there is a decline in clinical and biological status.</td>
</tr>
<tr>
<td>Discordant: clinically better, labs worse (&quot;disc clin better&quot;)</td>
<td>A 62 year old man with a severe lobar pneumonia requiring mech ventilation who improves clinically at 7 days and is extubated after an antibiotic course, but whose blood biomarkers are worse.</td>
</tr>
<tr>
<td>Discordant: clinically worse, labs better (&quot;disc clin worse&quot;)</td>
<td>A 54 year old man with multilobar pneumonia who completes a course of antibiotics, is extubated but then deteriorates clinically despite improving blood biomarkers of infection.</td>
</tr>
</tbody>
</table>

These vignettes were thought to accurately represent patient cases commonly seen in the ICU, and the varying degrees of diagnostic un/certainty encountered. Two of the vignettes (consistent clinico-biological improvement or worsening) functioned as controls, in that they clearly supported a decision to stop (improvement) or continue (worsening) antibiotics. The remaining two vignettes – hereafter termed disc clin better (clinical improvement/biological decline) and disc clin worse (clinical decline/biological improvement) - presented a greater diagnostic challenge, where the appropriate course of action was less clear. These discordant scenarios were intended to simulate situations in which there is equipoise in the inclination to stop/continue, because one of the factors key to decision making is deteriorating. The purpose of the two discordant scenarios was to explore the relative importance of clinical and lab-based trajectories in the inclination to stop antibiotics.

Each scenario offered a presumed highly accurate infection-detecting (polymerase chain reaction) PCR-based POCT. This POCT provides rapid diagnostics for a named panel of bacteria and viruses. Whereas clinical and lab-based findings are surrogates for presence of infection, this POCT marks the actual presence of an infective organism. The POCT result was always negative (i.e. no active lung infection). In one scenario (improvement), clinicians were subsequently told that the negative POCT result was erroneous (a laboratory error), and retesting gave a positive result. This explored the effect of a positive result on seemingly clear STOP judgments.

**Procedure**

Following informed consent, clinicians responded to all four vignettes (order randomised except for improvement, always presented last to preserve laboratory and POCT credibility). For each vignette (Table 1), clinicians made an initial antibiotic decision (stop/continue), rated their confidence in this
decision (1 = not at all to 6 = extremely confident) and selected reason/s for their decision (SM4). Participants were then offered the POCT (yes/no) and selected reason/s for their choice (Table 2).

Table 2

List of reasons presented to clinicians that accepted (left) vs. rejected (right) the POCT. Reasons were presented in a random order and clinicians could select as many as needed. The reasons were developed using the experiences of senior clinicians and previous work [13, 24].

<table>
<thead>
<tr>
<th>Reasons for PERFORMING POCT</th>
<th>Reasons for NOT PERFORMING POCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinicians that chose to perform the POCT were presented with the following list of reasons and asked to tick all that apply.</td>
<td>Clinicians that chose NOT to perform the POCT were presented with the following list of reasons and asked to tick all that apply.</td>
</tr>
<tr>
<td>• To supplement my clinical judgement;</td>
<td>• I prefer to rely on my clinical judgement;</td>
</tr>
<tr>
<td>• I trust this test;</td>
<td>• I do not trust the test;</td>
</tr>
<tr>
<td>• The test is necessary in this case;</td>
<td>• This test is unnecessary in this case;</td>
</tr>
<tr>
<td>• I feel confident interpreting this test;</td>
<td>• I don’t feel confident interpreting this test;</td>
</tr>
<tr>
<td>• Other (if selected, the participant was asked to elaborate using free text).</td>
<td>• Other (if selected, the participant was asked to elaborate using free text).</td>
</tr>
</tbody>
</table>

Irrespective of their decision to perform the POCT or not, the result was presented (always negative). Clinicians were then asked to update their original antibiotic decision (stop/continue) and their confidence (range 1–6).

In the improvement scenario only (always presented last), clinicians were then informed of the laboratory error and presented with a new, positive POCT result; in response, they were asked to update their antibiotic decision and confidence.

After completing all four vignettes, participants completed Grol’s Attitudes to Risk-Taking in Medical Decision Making questionnaire [15], adapted to ICU (SM5).

Statistical analysis

The study was powered to detect an effect of medium size ($f^2 = 0.15$) in a 2-tailed linear regression of final inclination-to-stop on patient trajectory, initial inclination-to-stop and in/voluntary POCT. Using G*Power 3.1, 55 responses were sought to detect this effect, given power = 80% and alpha = 0.05. This sample size calculation was validated using pilot data (see SM3).

Cluster-adjusted chi-square analysis was used to compare the proportion of clinicians that stopped antibiotics before vs. after a negative POCT (hypothesis 1). For a more sensitive measure of the inclination to stop antibiotics, clinicians self-rated (scale 1–6) their initial and final confidence in accord with the corresponding choice; i.e., positive (+) if the decision was to stop antibiotics and negative (-) if to
continue. This returned a continuous measure of each clinician's initial and final “inclination-to-stop” (-6 = minimal, 6 = maximal).

Inclination-to-stop was compared before vs. after the negative POCT result, using mixed-effects linear regression with a per-participant random intercept.

To test the effects of clinical trajectory (hypothesis 2), initial inclination-to-stop (hypothesis 3) and in/voluntary POCT (hypothesis 4) on final inclination-to-stop antibiotics, regression analysis was performed of final inclination-to-stop (-6 to 6) on patient trajectory (1 = improvement, 2 = disc clin better/disc clin worse, 3 = worsening), initial inclination-to-stop (-6 to 6) and in/voluntary POCT (1 = rejected, 2 = requested), using mixed effects linear regression with a per-participant random intercept.

Risk inclination scores (the per-participant sum to Grol's questionnaire) and level of experience (0 = trainee, 1 = consultant) were subsequently added to this model, to explore the effects of experience (hypothesis 5) and risk inclination (hypothesis 6) on final inclination-to-stop. Statistical analysis was performed using SPSS 26 (IBM) and Stata/MP 13.1(StataCorp).

The study was approved by the Imperial College Research Ethics Committee (ref 201C6499). All methods were performed in accordance with the relevant guidelines and regulations. In particular, to CHERRIES guidance for reporting e-survey results [16].

The datasets used and analysed during the current study are available from the corresponding author on request.

Results

Demographic data

Seventy-four clinicians accessed the survey. Of these, four (6%) did not complete a single patient scenario; their data were excluded from the analysis. Of the remaining 70 respondents, 62(89%) completed all four scenarios, 2(3%) completed two and 6(8%) completed one; yielding 258 scenario responses. Sample characteristics are displayed in SM6.

The effect of a negative POCT on antibiotic stop decisions (hypothesis 1)

Prior to receipt of a negative POCT result, an antibiotic stop decision occurred 54% of the time (138/258; clinicians’ reasons are presented in SM7). Following receipt of the negative POCT result, this increased to 70% (180/258; \( g^2(1) = 122.48, p < 0.001 \)). This trend was consistent across scenarios, with varying magnitude (Fig. 1).

In the improvement scenario (Fig. 1, panel 1), there was a high initial inclination to stop. The proportion of participants willing to stop antibiotics changed from 87% pre-POCT to 90% post-POCT (p = ns). Thus, a
negative POCT did not change their inclination to stop antibiotics (i.e. ceiling effect). In the disc clin better scenario (Fig. 1, panel 2), the initial proportion willing to stop was lower (73% pre-POCT) but the effect of the POCT on stop decisions was larger (88% post-POCT); this absolute increase of 15% was significant \((p<0.01)\). In the disc clin worse scenario (Fig. 1, panel 3), the initial proportion willing to stop was lower still (49% pre-POCT) and the effect of a negative POCT greater still (74% post-POCT): an absolute increase of 25\% \((p<0.01)\). In the worsening scenario (Fig. 1, panel 4), the initial tendency to stop was expectedly lowest (6\% pre-POCT) yet the effect of a negative POCT remained high (28\% post-POCT): an absolute increase of 22\% \((p<0.01)\). Even so, the proportion of participants willing to stop in this scenario remained a minority (28\%).

Commonly-selected reasons for stopping antibiotics were “continuing antibiotics is not clinically necessary based on the information provided” \((83\%,\ 114/138)\) and AMR concerns \((73\%,\ 100/138)\). This did not vary substantially across scenarios (see SM7). Commonly-selected reasons for continuing antibiotics were “stopping is inappropriate based on the clinical information provided” \((77\%,\ 92/120)\) and “disapproval from colleagues” in the improving and discordant scenarios \((56–79\%)\) – particularly disc clin worse \((79\%,\ 26/33)\), where it was the main reason for continuing (see SM7).

Clinicians’ mean inclination-to-stop pre-POCT vs. post-POCT, per scenario (Fig. 2) demonstrated that a negative POCT increased clinicians’ inclination-to-stop in all scenarios except improvement \((b = 0.69 \ [0.62–0.77], p < 0.001)\). Again, the biggest change was observed in the disc clin worse scenario, where pre-POCT inclination-to-stop was statistically 0 (indicating equivalence), but post-POCT inclination-to-stop was reliably positive (favouring stopping).

The two discordant scenarios allowed exploration of the hierarchy of importance between clinical and biological data in antibiotic stop decisions. We note, therefore, that mean inclination-to-stop (both pre-POCT and post-POCT) was lower in the disc clin worse scenario (Fig. 2, panel 3) than the disc clin better scenario (Fig. 2, panel 2), suggesting that clinical factors were more influential than surrogate laboratory-based data. However a negative POCT reduced the influence of clinical deterioration on inclination-to-stop, to a level comparable to a scenario of a clinical improvement (disc clin better).

After learning that the POCT result had changed from negative to positive (improvement only), the rate of stopping decreased significantly \((56/62, 90\%\ vs. 38/62, 61\%; g^2(1) = 56.78, p < 0.001)\), as did inclination-to-stop \(M = 4.19, SD = 2.82 vs. M = 0.95, SD = 4.35; t(61) = 6.90, p < 0.001, d = 0.88)\).

**The effect of patient trajectory, pre-POCT inclination-to-stop and in/voluntary POCT on STOP decisions (hypotheses 2–4)**

POCT was requested 65\% of the time \((167/258)\), the proportions differing by scenario \((g^2 (3) = 30.50, p < 0.001; improvement = 59\%,\ disc clin better = 59\%, disc clin worse = 85\%, worsening = 75\%)\) and by the initial antibiotics decision \((g^2(1) = 18.49, p < .001; stop = 52\%,\ continue = 79\%)\). Figure 3 displays the
number (proportion) of times that POCT was requested (green) vs. rejected (red), per scenario and initial decision. POCT was requested most frequently in the two scenarios with clinical worsening \((disc\ clin\ worse=85\%,\ worsening=75\%)\), especially in those who initially chose to continue \((disc\ clin\ worse=94\%,\ worsening=75\%\); Fig. 3). As hypothesised, final inclination-to-stop antibiotics was a function of the patient’s trajectory: clinicians were significantly less inclined to stop antibiotics (despite receiving a negative POCT) when the patient’s trajectory was ambiguous \((discordant\ scenarios)\) or \(worsening\), as opposed to \(improving\) \((b=-0.73 \ [-1.33, -0.14],\ p=0.01)\). Final inclination-to-stop was also a function of the clinician’s initial leaning, with high [low] inclination-to-stop pre-POCT predicting high [low] inclination-to-stop post-POCT \((b=0.66 \ [0.56, 0.76],\ p<0.001)\). Finally, clinicians that actively requested (vs. passively received) POCT results were significantly more inclined to stop \((b=1.30 \ [0.58, 2.02],\ p<0.001)\). Indeed, of those who initially elected to “continue” and requested the POCT \((n=95)\), 43% changed their minds (i.e. switched to stop, \(n=41\)); of those who initially elected to “continue” and did not want the POCT \((n=25)\), only 8% changed their minds \((n=2)\). As such, the vast majority of those who changed their minds (from “continue” to “stop”) had requested the POCT \((95\%, 41/43)\).

Reasons for requesting/rejecting POCT are presented in SM9. The commonest indication for requesting POCT was “to supplement my clinical judgment” \((95\%, 159/167)\), while the commonest indication for rejecting POCT was “the test is unnecessary in this case” \((81\%, 74/91)\).

**Effect of clinician characteristics on inclination-to-stop (hypotheses 5–6)**

The clinician’s grade (trainee or consultant) did not influence inclination-to-stop antibiotics \((p=0.699)\), nor did attitudes towards risk-taking \((p=0.872;\ see\ also\ SM10)\). However, the study was not powered to detect these effects; therefore we cannot confidently rule out the possible influence of seniority and/or risk appetite.

Finally, clinicians were deliberately not given the opportunity to de-escalate (rather than stop) antibiotics. Recognising this potential limitation, we asked clinicians whether they would have de-escalated, had the option been available. Most clinicians said yes \((74\%, 52/70)\), a minority said no \((14\%)\) and 11% did not answer.

**Discussion**

To our knowledge, this is the first study to use rigorous experimental methods to generate and test hypotheses regarding cognitive-behavioural factors that might influence antibiotic stop decisions in ICU. Other studies have identified cognitive-behavioural drivers of stop decisions \([3]\), and influential factors in such decisions \([24]\). None has quantitatively measured the degree to which they influence stop decisions, nor the degree to which a decision may (or may not) change in clinical scenarios of uncertainty, given the availability of a PCR-based POCT result suggesting the absence of infection.
What is the effect of a negative POCT on antibiotic stop decisions?

Having a negative POCT result significantly increased clinicians’ inclination to stop antibiotics. A negative POCT did not trigger stop decisions indiscriminately; rather, it appeared to operate as one input to clinicians’ decisions, increasing their inclination to stop by degree. A negative POCT thus appears to operate as a prompt or nudge for antibiotic stop decisions.

The efficacy of this nudge – i.e. the extent to which it brings about stop decisions – varied by scenario [17, 18]. It was most striking in an ambiguous scenario featuring clinical deterioration but biological improvement (disc clin worse), where a negative POCT result shifted the majority decision from ‘uncertain’ to ‘stop’ (49% vs. 74% stopped). Indeed, the post-POCT stop rate in this scenario began to approach the pre-POCT stop rate in scenarios featuring clinical improvement (improvement, disc clin better), suggesting that a negative POCT led clinicians to reinterpret clinical deterioration. A psychological explanation for this is the “plausible coherence” hypothesis; the human mind tries to resolve conflicting information into an acceptable story [7]. A negative POCT result may have enabled this; clinicians with uncertainty about stopping may have been ‘nudged along’ to a comfortable stop decision by a negative POCT. This was not however sufficient when the patient’s clinical and biological trajectory were declining (the worsening scenario): while a negative POCT result did increase stopping significantly in this scenario, the majority decision was ultimately to continue. In this scenario, it would seem implausible to argue against the clinico-biological data. POCT may therefore be most useful as an influencing strategy in ambiguous scenarios.

Why do clinicians not stop antibiotics when POCT data suggests that they can?

As hypothesised, three factors were found to “compete” with (i.e., reduce or moderate) the effect of a negative POCT on antibiotic stop decisions. The first was the patient’s clinico-biological trajectory. As the trajectory deteriorated, so too did clinicians’ inclination to stop, despite receipt of a negative POCT. This speaks to plausible coherence; POCT is merely one input to clinicians’ decisions and will be considered in light of all the available data. Interestingly, we observed a hierarchy in this “available data”: clinicians were less inclined to stop antibiotics when there was clinical improvement with biological worsening (disc clin better) vs. clinical worsening with biological improvement (disc clin worse). This confirms that clinical factors are more influential than surrogate laboratory-based data [19], and reflects the historical evolution of clinical diagnosis. Laboratory-based findings were only incorporated into clinical practice later, in William Osler’s era [20].

The second factor “competing” with a negative POCT was strength of initial inclination. This determined the final inclination to stop, irrespective of a negative POCT [21]. High confidence in the initial decision to
continue antibiotics might not be swayed by a negative POCT. This could explain the failure of negative POCT to increase stopping in trials such as VAP-rapid [13].

The third "competing" factor might be termed "disinterest in POCT Clinicians who actively requested the POCT result were significantly more likely to act upon its results (i.e. stop antibiotics) than those who involuntarily received it. There are several reasons why clinicians might decline a POCT. The most commonly-selected reason in the present study was that "the test is unnecessary in this case", indicating conviction in their decision. Prior work has recognised lack of trust in the validity of POCT amongst clinicians [22, 23]; presently, only a minority of POCT-rejectors indicated lack of trust, but this may be due to our deliberate presentation of the POCT as reliable. Whatever clinicians' reasons for rejecting POCT, unregulated POCT without appropriate guidance will reduce its utility. The most promising route forward might be a combined approach, including POCT prompts (e.g., algorithmic triggers to flag cases where POCT is most useful and nudge POCT requests) as well as active attempts to increase clinicians' appreciation of POCT as potentially influential in antibiotic stop decision making. Future work might also identify the factors that influence clinicians' inclination/decision to request more information – be they clinical (e.g., patient trajectory), organisational (e.g., hospital culture) or individual (e.g., confidence, open-mindedness).

Inclination for POCT may be the result of uncertainty ("I'm not sure what to do, I need more information") or affirmation of a draft judgment ("I think there is [not] an infection, but I want proof"). Presently, POCT was most requested and apparently most useful in situations of clinical deterioration (disc clin worse, worsening), where the inclination to stop after a completed course may be hindered by concerns about the possibility of ongoing and unidentified infection. High demand for POCT in the worsening scenario is interesting and could represent an attempt to seek new information on suspected bacteria, or to counter the proposition that a clinical deterioration was due to infection, to inform the antibiotic stop decision better. The necessity concerns framework (NCF) details the benefit-risk relationship to treatment decision [24]. In a previous study (also using vignette-based interviews about nosocomial infection), ICU clinicians described 'erring on the side of caution'; clinicians viewed antibiotics' necessity (i.e., protection for their patients and themselves) as outweighing concerns about antibiotic toxicity and AMR [25].

**Do clinician characteristics (experience and risk-taking) influence antibiotic stop decision making?**

We found no evidence to suggest that clinician experience (trainee to consultant) or risk averseness influenced willingness to stop antibiotics [15]. However, the role of experience and expertise warrants further investigation. Future work might also investigate the role of systemic factors such as hospital/ward culture and baseline prevalence of infection.

**Strengths and limitations**

A negative POCT result facilitated antibiotic stop decisions; therein lies justification for the use of POCT. However, there remains the question of whether this simulated effect, can be used to effect change in real
Perhaps it is too easy to stop antibiotics in a hypothetical patient scenario and certain factors are given disproportionate weight. Furthermore, it is unlikely that all influencing factors from this study are made explicit and/or considered simultaneously at the point of decision in reality. Our vignettes were simplistic and may have omitted other relevant factors. The model's simplicity was intentional; only through careful control of the scenarios' components (clinical and biological) could we assess their effects on stop decision making; indeed, the predictive accuracy of simple models is usually reduced by adding complexity [25]. The present findings would benefit from replication in the context of a) more detailed vignettes and b) simulated clinical settings.

Relatively, we did not offer participants the option to change/de-escalate antibiotics (lest it become the "safest" and therefore default option – particularly in ambiguous scenarios). We are aware that this limits the generalisability of our findings. It could also explain some of our results, such as the substantial shift towards "stop" following a negative POCT in the worsening scenario: it is possible that participants were not electing to stop per se, but rather trying to express that they would not continue along the same path. Our study also may not have fully accounted for consideration of a non-pulmonary cause to explain clinical worsening, i.e. 1) declining the POCT (due to the belief that lungs that are not the issue) and/or 2) requesting the POCT in the worsening scenario (to determine bacteria that may influence a change/escalation-decision rather than a stop-decision). Follow-up studies should manipulate the likelihood of alternative sources of infection and allow for de/escalation.

Finally, we chose not to examine the effect of a positive POCT result (suggesting infection), presuming that it would inhibit stop decisions (the very phenomenon that we wished to study).

With that, the present work helps to specify conditions for targeted and effective use of POCT as part of ASP strategies. In so doing, it may shed light on the low success of VAPrapid and similar initiatives. It identifies specific situations in which POCT might be most gainfully used, which could inform algorithms and/or guidelines as to selected deployment of POCT for maximum advantage.

**Conclusion**

This is the first study to generate and quantitatively test hypotheses regarding specific cognitive-behavioural factors that might influence antibiotic stop decisions, using rigorous experimental methods. A negative POCT result increased clinicians’ inclination to stop antibiotics in most scenarios; therein lies justification for the use of POCT. However, clinical deterioration, an intuitive unwillingness to stop, and disinterest in POCT (i.e., failure to request) reduced its effect. We conclude that judicious use of POCT to reduce uncertainty can improve antibiotic STOP decisions in those prepared to request it. These and other identified behavioural factors must be signposted in ASPs, with the necessary prompts. Such work might inform future ASP study design, where prediction of likely clinician antibiotic prescribing responses can be incorporated as an additional outcome measure.

**Declarations**
Acknowledgements:

All clinicians who agreed to participate in this study are acknowledged with appreciation, in particular those who assisted in the piloting of vignettes: Dr James McIntee, Dr Frederick Hill, Dr Kaladheran Abogantaaen. Members of the WHY STOP Consortium are also acknowledged for providing valuable comments on the manuscript.

Competing Interests:

There are no competing interests related to this work declared by the authors.

Provenance:

SS conceived the idea. SS, MN, SM and MV developed the protocol. SM and MN developed the data collection tool. SM created the Study website. MN analysed the data. SS, MN, SM, LM, NM interpreted results. SS wrote the first and subsequent drafts with MN. SS, MN, SM, MV and WHY STOP Consortium members reviewed the manuscript.

Financial:

Non funded

Conflicts of Interest:

Not directly related to this.

References


Figures

Figure 1

*Number and % of clinicians that chose to STOP antibiotics, before and after a negative POCT result, per scenario. From left to right, the scenarios represent improvement (n=62 responses); disc clin better (n=66 responses); disc clin worse (n=65 responses); worsening (n=65 responses). * difference in proportions (pre-POCT vs. post-POCT) significant at p<0.01.*
Figure 2

Mean inclination-to-stop antibiotics, before vs. after a negative POCT result, per scenario. Values above zero indicate an inclination to stop antibiotics; values below zero indicate an inclination to continue. Bar height indicates the strength of the leaning. Error bars indicate 95% confidence intervals (CI). Standard deviations (indicating noise/variance) are presented and discussed in SM6. * difference in means (pre-POCT vs. post-POCT) was significant at p<.001.
Figure 3

Number and proportion of times that POCT was requested (green) vs. rejected (red) by those who initially elected to stop (left panel) vs. continue (right panel) antibiotics, per scenario

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- WHYSTOPSUPPLMATERIALS.docx