The implementation of CRP POCT in Belgian primary care regarding adults with acute cough: a mixed methods study

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Abstract (English)

Background: Antimicrobial resistance (AMR) is a growing global concern, partly because of inappropriate antibiotic use. General practitioners (GPs) still frequently prescribe antibiotics for acute respiratory tract infections, even though evidence shows that these are usually self-limiting. C-reactive protein (CRP) point-of-care testing (POCT) can help reduce antibiotic prescriptions in primary care and thereby combat AMR. Further research on organizational aspects is necessary to guide a possible future implementation in Belgian primary care.

Aim: This study aimed to map the experience of general practitioners and other relevant stakeholders regarding the implementation of CRP POCT devices in primary care for adults with acute cough.

Methods: A mixed methods study was conducted combining reflexive thematic analysis of four focus groups (n = 32, GPs and relevant stakeholders) with an online survey among GPs.

Results: Our thematic analysis identified four major themes:

I. *'CRP POCT is an objective tool that reduces diagnostic uncertainty'*: CRP POCT was described as an objective adjunct to clinical assessment, particularly in cases of diagnostic uncertainty. It may also be used to help convince patients. The potential indications are broad, with GPs especially highlighting its value in the pediatric population.
II. *'Easy to use CRP POCT with reliable support integrates well in existing workflow'*: CRP POCT devices were generally described as user-friendly and compatible with the GP's existing workflow. GPs emphasized the importance of standardized technical support in case of device-related issues.
III. *'CRP POCT supports decisions and strengthens patient communication, fostering antibiotic stewardship'*: CRP POCT supports decision-making for GPs, initiates co-consultation between professionals in cases of uncertainty and reinforces patient-doctor communication. The number of unnecessary antibiotic prescriptions seemed to decrease.
IV. *'GPs expressed concerns regarding costs and reimbursement of CRP POCT'*: The high costs and the absence of reimbursement strategies caused concern among GPs and need to be reviewed before further implementation is possible.

The survey results were generally consistent with the insights gained from the focus groups.

Conclusions: Findings suggest that CRP POCT represents a promising supplementary tool in daily Belgian primary care. It may support decision-making across various indications, while also reinforcing patient-doctor communication and interprofessional collaboration. CRP POCT could also contribute to the global fight against AMR, since it seems to reduce the number of unnecessary antibiotic prescriptions. Further development of clear frameworks regarding costs and reimbursement, standardized technical support systems and national guidelines must be addressed before nationwide implementation is possible.

Abstract (Dutch)

Achtergrond: Antimicrobiële resistentie (AMR) is een groeiend wereldwijd probleem, deels als gevolg van ongepast gebruik van antibiotica. Huisartsen schrijven nog steeds frequent antibiotica voor bij acute respiratoire infecties, hoewel uit onderzoek blijkt dat deze meestal zelflimiterend zijn. C-reactief proteïne (CRP) point-of-care testing (POCT) kan bijdragen aan een vermindering van antibioticavoorschriften in de eerste lijn en kan bijgevolg de strijd tegen AMR ondersteunen. Verder onderzoek naar organisatorische aspecten is noodzakelijk om een mogelijke toekomstige implementatie in de Belgische eerste lijn te faciliteren.

Doelstelling: Dit onderzoek had als doel de ervaringen van huisartsen en andere relevante betrokkenen in kaart te brengen met betrekking tot de implementatie van CRP POCT toestellen in de eerste lijn bij volwassenen met een acute hoest.

Methoden: Er werd een gemengd methodologisch onderzoek uitgevoerd waarbij een reflexieve thematische analyse van vier focusgroepen (n = 32, huisartsen en relevante betrokkenen) werd gecombineerd met een online enquête bij huisartsen.

Resultaten: Onze thematische analyse identificeerde 4 hoofdthema's:

I. *'CRP POCT is een objectief hulpmiddel dat diagnostische onzekerheid vermindert'*: CRP POCT werd omschreven als een objectieve aanvulling op de klinische inschatting, vooral bij diagnostische onzekerheid. Het kan ook gebruikt worden om patiënten te overtuigen. De potentiële indicaties zijn breed waarbij huisartsen vooral de waarde ervan benadrukten bij de pediatrische populatie.
II. *'Gebruiksvriendelijke CRP POCT met betrouwbare ondersteuning past goed in de bestaande workflow'*: CRP POCT toestellen werden over het algemeen omschreven als gebruiksvriendelijk en compatibel met de bestaande workflow van de huisarts. Huisartsen benadrukten het belang van gestandaardiseerde technische ondersteuning bij problemen met de apparatuur.
III. *'CRP POCT ondersteunt besluitvorming en versterkt communicatie met patiënten wat bijdraagt aan het verantwoord gebruik van antibiotica'*: CRP POCT ondersteunt de besluitvorming van huisartsen, zet aan tot overleg tussen zorgverleners in geval van onzekerheid en versterkt de arts-patiënt communicatie. Het aantal onnodige antibioticavoorschriften leek af te nemen.
IV. *'Huisartsen uitten hun bezorgdheden over de kosten en terugbetaling van CRP POCT'*: De hoge kosten en het ontbreken van terugbetalingsregelingen baarden de huisartsen zorgen en moeten worden herzien voordat verdere implementatie mogelijk is.

De resultaten van de enquête kwamen over het algemeen overeen met de inzichten die uit de focusgroepen naar voren kwamen.

Conclusie: De bevindingen wijzen erop dat CRP POCT een veelbelovend aanvullend instrument is in de dagelijkse Belgische eerstelijnszorg. Het kan de besluitvorming ondersteunen bij verschillende indicaties, terwijl het tegelijkertijd de arts-patiënt communicatie en de interprofessionele samenwerking versterkt. CRP POCT zou ook kunnen bijdragen aan de wereldwijde strijd tegen AMR, aangezien het aantal onnodige antibioticavoorschriften lijkt te verminderen. Verdere ontwikkeling van duidelijke kaders met betrekking tot kosten en terugbetaling, gestandaardiseerde systemen voor technische ondersteuning en nationale richtlijnen is nodig voordat nationale implementatie mogelijk is.

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1. Introduction

1.1 Antimicrobial resistance (AMR): a global issue with important consequences

The World Health Organization (WHO) has declared antimicrobial resistance (AMR) as one of the major threats to both present and future global health (1). The Belgian "One Health" national action plan defines AMR as 'the ability of micro-organisms to become increasingly resistant to the antimicrobial agents to which they were previously susceptible'. They highlight that an estimated 530 deaths per year are directly linked to AMR in Belgium (2). Globally, bacterial AMR was estimated to be directly responsible for 1.27 million deaths in 2019 and played a contributing role in 4.95 million deaths (1).

The challenge and importance of combating AMR lies in the wide-ranging consequences that it has and will have across several domains. First and foremost, bacteria become resistant more quickly, causing antimicrobials to lose their effectiveness and resulting in the emergence of highly mutated bacteria and recurrent diseases (3,4). Subsequently, this leads to an increase in preventable mortality, hospital admissions and the duration of hospital stays (1–4). Moreover, other critical medical procedures - like surgery, cancer treatment and transplantation - can get compromised in the future because of the heightened risks of infection (1,2).

These outcomes have far-reaching economic implications. In Belgium in 2019, the cost of AMR was estimated at 24 million euros annually (2). According to OECD (Organization for Economic Coordination and Development) estimates, cumulative costs in Belgium could reach 787 million euros by 2050 (2). Globally, The World Bank expects that AMR could lead to an additional healthcare cost of 1 trillion US dollars by 2050 (1).

1.2 The main drivers of AMR: antibiotic misuse and overuse

There are several mechanisms through which bacteria develop resistance, thus promoting the emergence of AMR. Broadly, we distinguish between natural and acquired types of resistance (5,6). Natural resistance can be divided into intrinsic resistance and induced resistance (5,6). Certain bacterial species are characterized by a natural inherent resistance to certain classes of antibiotics, which is called intrinsic resistance (5,6). In contrast, induced resistance is the result of exposure to an antibiotic allowing the naturally pre-existing genes to be expressed to resistant levels (5,6). Acquired resistance, on the other hand, arises in response to a DNA mutation acquired during replication of a DNA transfer (5,6). The practical ways in which bacteria circumvent the effectiveness of antibiotics, thereby causing resistance, are typically categorized into four different strategies: 1) limiting the uptake of the drug, 2) modifying the drug target, 3) inactivating the drug and 4) providing active drug efflux (5,6).

Given the natural occurrence of AMR, it is assumed to have existed since ancient times as a natural process driven by genetic changes resulting from exposure to antibiotics (1,5). However, the problem

grew more rapidly, since the broad implementation of antibiotics. The global overuse and misuse of antibiotics accelerate the occurrence of the natural resistance process, thereby promoting the worldwide spread of AMR (5).

The overuse of antibiotics kills sensitive bacterial species, but on the other hand allows drug-resistant bacteria to multiply (5). Bacteria who survive inhibitory and (misused) sub-inhibitory concentrations of antimicrobials are genetically selected, providing the development of resistant bacterial strains, in this way contributing to an increase in AMR (6). The fact that countries that use fewer antibiotics show lower grades of AMR further supports this theory (7). Not only the use of antibiotics in humans, but also in animals and plants contributes to AMR. Whole genome sequencing of the strain of S. aureus CC398 showed evidence of livestock-to-human jumps of resistance genes, which is just one example of resistance genes crossing species (7). This further highlights the importance of an integrated "One Health" approach in which antibiotic use in both humans, animals and plants is regulated (2).

1.2.1 Inadequate antibiotic usage in hospitals, the agricultural sector and other contributing factors

As stated above and according to WHO, the main drivers of AMR are the misuse and overuse of antibiotics in humans, animals and plants (1). There are several additional contributing factors to the misuse and overuse of antibiotics highlighted in literature, according to the degree of development of a country (8).

In developed countries, such as Belgium, hospital acquired infections (nosocomial infections) are one of the greatest sources of antibiotic-resistant infections (8). This is mainly facilitated by the prophylactic use of antibiotics for both surgery and immunocompromised patients (8). Another important contributor is the excessive use of antibiotics in food producing animals to prevent infections and promote animal growth (8). As a result, insufficient regulation regarding antibiotic use in hospitals and in the agricultural sector co-influence the development and evolution of AMR (8). On top of that, the lack of research into new antibiotics partially slows down the battle against AMR, because there is currently only a limited economic benefit to research for pharmaceutical companies (8).

In developing countries, other factors influence antibiotic misuse, such as the lack of surveillance of resistance development and the poor quality, the clinical misuse and the ease of availability of antibiotics (8). As people increasingly travel around the globe, these factors become more important in developed countries as well (8).

1.3 Inadequate antibiotic usage in primary care

Evidence shows that antibiotic misuse and overuse occurs not only in hospital setting, since most antibiotics in humans are prescribed in primary care. The European Centre for Disease Prevention

and Control (ECDC) and other supportive evidence states that 80-90% of antibiotic prescriptions are made in primary care and mainly for respiratory tract infections (9–12).

Concerning Belgium, our prescription rates in ambulatory care exceed the European average since many years (13). For example, according to information of the Rijksinstituut voor ziekte- en invaliditeitsverzekering (RIZIV) and Domus Medica, antibiotic consumption in primary care in our neighboring country, the Netherlands, is up to 2.5 times lower without the repercussion of increased risk of complications (14,15). These observations clarify the urgent need for targeted interventions to address this national issue. An important group to target in Belgian primary care are general practitioners who are responsible for 75% of all antibiotic prescriptions in Belgian primary care (15).

1.3.1 Contributing factors to antibiotic prescribing in primary care: physician- and patient-related factors

Inadequate antibiotic prescribing behavior in primary care is influenced by both physician- and patient-related factors (16). First of all, the lack of adequate knowledge and widespread misconceptions are still frequent among physicians (17). In daily practice, many physicians continue to prescribe antibiotics despite being aware of their limited beneficial effect in certain conditions (16). Other factors influencing prescribing behavior are the course of infection (e.g. duration and serverity), diagnostic uncertainty and the influence exerted by the pharmaceutical industry (17).

Patients' behavior regarding antibiotic use also plays a role in the development and progression of AMR. Early discontinuation of antibiotic treatment and self-administering leftover antibiotics without prior consultation with a physician are frequently reported (18). Other patient-related factors of influence on general antibiotic prescribing by physicians are the expectations of patients, the risk of losing a patient and patient dissatisfaction (17).

With regard to patients' expectations concerning the prescription of antibiotics, it appears that GPs often overestimate those expectations leading to sometimes unnecessary (delayed) antibiotic prescriptions to meet the patients' implicit expectation. This emphasizes the importance of adequate communication between the GP and the patient to explore their ICE (ideas, concerns, expectations) and the reason for their consultation (19,20).

1.3.2 Respiratory infections as a leading reason to start antibiotics in primary care

Differentiating between viral and bacterial respiratory infections (RTIs) remains a common challenge in clinical practice, especially in primary care. Approximately 70% of RTIs are viral and many others are self-limiting bacterial infections, causing the majority of RTIs to have a mild course regardless of the underlying pathogen (21). However, despite these recommendations, RTIs are still among the leading reasons for general practitioners to initiate antibiotic treatment (21–24). This in turn leads to an exacerbation of AMR (25–28). In accordance, the Belgian Antibiotic Policy

Coordination Committee (BAPCOC) guidelines discourage the systematic use of antibiotics for this indication (29).

A study covering data from the French National Health Insurance (NHI) database, examined the appropriateness of antibiotic use in acute lower respiratory tract infections (LRTI) between 2010 and 2017. It was discovered that during the cold season, LRTIs accounted for 40% of the overall outpatient antibiotic use in the entire population. This number was even higher with 56% and 64% for the elderly and young children, respectively. 42,5% of the LRTIs treated with antibiotics were viral infections and 57.5% were bacterial (30). These results align with a study in the United States covering data from 2010 to 2011, in which it was found that acute respiratory infections (ARIs) accounted for 221 of 506 total antibiotic prescriptions per 1000 inhabitants. It was estimated that 50% of antibiotic prescriptions for ARIs would have been unnecessary, accounting for 34 million antibiotic prescriptions each year (31).

Specifically in Belgium, the overprescription of antibiotics in primary care for respiratory infections was examined in a retrospective observational study, covering data from 2012. Data were extracted from Intego, a registration network that anonymously collects data from the digital medical records of GPs across the Flanders region. The study revealed that, in Flanders, more than 60% of patients with a respiratory infection (bronchitis, tonsillitis, sinusitis or otitis media) were prescribed an antibiotic. Furthermore, the use of recommended antibiotics was not in the proposed acceptable range (12).

In the context of respiratory tract infections, a working diagnosis of acute bronchitis was associated with increased odds of antibiotic prescribing, although most guidelines and reviews commonly recommend against this method (16,29,32,33). Other factors mentioned were: the presence of fever, purulent sputum, abnormal respiratory auscultation and tonsillar exsudate on clinical examination of the patient and the physician's perception of the patient's preference for antibiotic treatment (16).

1.4 Belgium's initiatives against AMR

In Belgium, several initiatives against AMR have already been taken. It started in 1999 with the founding of the BAPCOC (29,34). The overall aims of BAPCOC include: 1) collecting and publishing relevant data about antibiotic consumption and resistance, 2) informing and raising awareness of AMR in the form of campaigns and 3) formulating guidelines and recommendations regarding antibiotic use (34). All recommendations are gathered by the Belgian Centre for Pharmacotherapeutic Information (Belgisch Centrum voor Farmacotherapeutische Informatie, BCFI), making this information accessible for physicians all over the country (2).

As developed by the WHO in 2015 (35), the government of Belgium decided on a national 'One World One Health' action plan to combat AMR in the period from 2020 to 2024 (2). This plan aimed to achieve a unified approach against AMR including safety and health for both humans, animals and for the environment. In this initiative, all important stakeholders - including scientific experts,

prescribers, laboratories, patients, animal stock keepers, teaching staff et cetera - must work together to diminish antibiotic misuse and overuse (2).

In 2023, the National Council for Quality Promotion (Nationale Raad voor KwaliteitsPromotie, NRKP) came up with 3 quality indicators for targeted antibiotic prescriptions, this way aiming to reduce antibiotic prescriptions of GPs by 40%. The first indicator is a quantitative representation of the percentage of antibiotic prescriptions among all prescriptions. The other two indicators refer to the use of second-line antibiotics such as amoxicillin with clavulanic acid, cephalosporins, macrolides and quinolones. These data are extracted for every individual GP annually to identify any deviations from good evidence-based medical practice (36).

In the Belgian electronical medical records (EMR), GPs can voluntarily consult their personal 'antibiotic baramoter' data. This barometer is a quality monitoring tool, which automatically analyses EMR data of a general practice every 3 months regarding common infections and the associated antibiotic prescriptions. This tool confronts GPs with their number of antibiotic prescriptions, with the aim of reflecting and improving antibiotic prescribing behavior (36,37).

1.4.1 Unmet targets in combating AMR in Belgium

Despite all initiatives stated above, the Belgian Monitoring of Antimicrobial Consumption and Resistance (BELMAP) report of 2024 stated that the targets for reducing AMR have not been completely achieved yet (38). In accordance with the European Council Recommendations, specific national targets were set to help decrease the incidence of key resistant pathogens - measured as the number of resistant bloodstream infections per 100.000 inhabitants - by 2030. Belgium's objectives include a 6% reduction in methicillin-resistant Staphylococcus aureus (MRSA), a 12% reduction in third-generation cephalosporins resistant Escherichia coli and a 2% reduction in carbapenem resistant Klebsiella pneumoniae. While two of these three targets were achieved in 2020, recent data in the BELMAP report indicates an upward trend in the incidence of all three resistant infections between 2022 and 2023, underscoring the need for continued vigilance and intensified efforts (38).

To help lower the prevalence of AMR, the European Council set a national target of a 40% reduction in the consumption of systemic (reimbursed) antibiotics compared to 2019 levels. The BELMAP report demonstrates that in 2023, consumption had only decreased by 3.2%. Additionally, BAPCOC established an objective of achieving an 80:20 ratio of amoxicillin to amoxicillin-clavulanic acid. In 2023, this ratio was 52:48, representing a deterioration compared to the 2013 ratio of 54:46 (38).

1.5 Usage of CRP POCT in patients presenting with RTIs to combat AMR in primary care

1.5.1 CRP value as a differentiator between viral and bacterial (respiratory) infections

C-reactive protein (CRP) testing could serve as a potential tool for antibiotic stewardship in respiratory infections, by helping the differentiation between viral and bacterial infections (23). CRP is an acute-phase protein which is produced in the liver in response to inflammation or tissue damage, as is the case in respiratory infections (22). Normal CRP blood values are lower than 10 mg/L (39). Within a few hours after the onset of an infection, CRP levels start to rise rapidly, peaking after 48 hours up to 350-400 mg/L (39).

Research showed that a CRP value can sometimes help to differentiate between viral and bacterial infections (21–24,39). Especially very low or very high values can be interpreted as, respectively, viral or bacterial infections (40). Higher CRP values are generally associated with bacterial infections, partly because CRP binds to phosphorylcholine, a molecule only found in bacteria and not in viruses (39,41,42).

Overall, research has not yet been able to discover clear or standardized cut-off values for CRP (41,42). A 2009 systematic review attempted to assess the diagnostic accuracy of CRP at different cut-off points in patients presenting with symptoms suggestive for community-acquired pneumonia (CAP) in ambulatory care (42). The reference test was a chest X-ray. It was discovered that a CRP higher than 20 mg/L is approximately twice as prevalent in patients with CAP than without. The chance of CAP is approximately three times lower with a CRP less than 20 mg/L. This causes doctors to still mainly rely on their clinical assessment of the patient, especially in the case of CRP values in the 'gray zone' (42).

Consequently, recommendations and guidelines about the interpretation of CRP values in respiratory infections vary widely. BCFI recommends antibiotic use in LRTIs starting from a CRP value of 20 mg/L (29). The NHG (Nederlands Huisartsen Genootschap, Netherlands) and NICE (National Institute for Health and Clinical Excellence, United Kingdom) guidelines on the other hand recommend antibiotic use starting from a CRP value of 100 mg/L and consider using antibiotics between 20 and 100 mg/L (43,44). For a long time, CRP blood tests only played a minor role in ambulatory care due to the long delay between sample collection and results. However, the newer CRP point-of-care test (CRP POCT), a device that derives a CRP value from a single blood drop, delivers results within minutes. This offers valuable support for ad hoc decision-making and could be used in ambulatory care, where time is often scarce (22).

1.5.2 CRP POCT as a tool to reduce antibiotic prescriptions in respiratory infections

A 2019 systematic review evaluating the impact of CRP POCT in ambulatory care (not only RTIs) demonstrated a significant reduction in antibiotic prescribing at the index consultation compared with usual care, thereby contributing to the battle against AMR. However, there was no significant

effect of CRP POCT on patient satisfaction, clinical recovery, reconsultations or hospital admission (22).

A 2020 systematic review and meta-analysis focusing on the specific impact of CRP POCT on antibiotic prescribing in the context of RTIs in primary care showed similar results. A significant reduction on antibiotic prescriptions was found, however with higher rates of reconsultations within 30 days (23). A Cochrane systematic review of 2022 further substantiated these findings. A mean reduction of 23% in antibiotic prescribing for RTIs in adults was found in ambulatory care. They also demonstrated a reduction in antibiotic prescriptions both at the index consultation and in the 28 days follow-up period (24). Specifically for children, a recent controlled trial showed a relative reduction of 22% in antibiotic prescriptions when a clinical decision tree, CRP POCT and safety-netting advice was provided versus usual care (45).

An earlier review by Engel et al. (2012) on the contrary only showed limited evidence for the usefulness of CRP POCT in adults presenting with RTIs in primary care. Only one included study demonstrated a reduction in antibiotic prescriptions for RTIs when CRP POCT was used and the usefulness of CRP POCT was higher when combined with clinical assessment (46). Furthermore, a register-based study in Denmark (2014-2017) showed that clinicians with a high tendency to use CRP rapid testing prescribed 22% more antibiotics than those with a lower tendency. Thus, the validity of CRP POCT is reduced when utilized in cases of a lower probability of bacterial infection and CRP POCT should not be used to 'rule-in' bacterial infection (47,48).

Furthermore, subgroup analysis in two previously mentioned systematic reviews showed no significant reduction in antibiotic prescriptions when clear cut-off values were not provided for interpretation (22,23).

1.5.3 Cost-effectiveness of CRP POCT

A recent 2024 systematic review assessing the cost-effectiveness of POCT diagnostics for AMR provided moderate evidence suggesting that CRP POCT may be a cost-effective intervention to reduce antibiotic use in patients with RTIs. The cost-effectiveness was most pronounced in nursing homes and among patients with chronic obstructive pulmonary disease (COPD). The review additionally stated that the economic value improved even more when combined with communication training for doctors (49).

Furthermore, an observational study in Norway and Sweden among adults with acute cough and LRTI in primary care, showed a 70% probability of CRP POCT being cost-effective (50).

1.5.4 CRP POCT usage in ARIs according to guidelines

Thus, CRP POCT could represent a promising tool to reduce antibiotic resistance in patients with RTIs in primary care. Despite its proven clinical value, CRP POCT has not yet been implemented into Belgian primary care guidelines. CRP POCT is already included in several guidelines in other

countries, namely the Netherlands, Denmark, Sweden, Norway, Switzerland and the UK, where it has led to a reduction in antibiotic prescriptions everywhere (51). For example, in our neighboring country, the Netherlands, implementation of CRP POCT among GPs has led to a further 14% decrease of overall antibiotic prescriptions since 2011 (51).

The NHG guidelines in the Netherlands for example recommend consideration of a CRP test when in doubt of pneumonia, but only in patients without risk factors for a severe course of the disease. In patients with risk factors for a severe course, CRP determination probably has fewer implications for treatment (43).The NICE guidelines in the UK, covering suspected acute respiratory infection in patients aged over 16 years old, also recommend the usage of CRP POCT when clinical assessment is insufficient to decide whether to start antibiotics or not (44).

1.6 Aim of the study

This study aims to assess the experience of GPs and relevant stakeholders with the implementation of three clinically validated CRP POCT devices in general practice as part of standard care regarding adults with acute cough. This research design will be evaluated using both qualitative and quantitative research with focus group discussions and a survey (cfr. infra, Methods). By gathering insights from these key stakeholders, we aim to evaluate the feasibility, practical organization, barriers and facilitators associated with CRP POCT use in general daily practice. Ultimately, we hope that these results can have a supportive and informative role in the possible further implementation of CRP POCT in primary care in Belgium with the main goal of reducing antibiotic prescription rates and thus reducing AMR.

2. Methods

To address our research question, we conducted a study with a mixed methods design. Qualitative data were collected using focus groups under the form of semi-structured interviews, based on an interview guide. Quantitative data were collected through an online survey.

Four focus groups were organized between January and March 2024, while the use of the CRP POCT devices took place between October and December 2023. A total of 32 participants participated in the focus groups after recruitment through an email invitation. Both GPs who used the CRP POCT devices as well as employees of the firms and the laboratory were included. Twenty GPs (including one general practitioner in training) from 14 different general practices participated as well as 5 different people from the three companies who delivered the devices and 7 employees from different laboratories. Three different CRP POCT devices were discussed during the focus groups, namely the QuickRead go easy CRP test by Aidian, the Cobas b101 CRP test by Roche and the Afinion 2 CRP test by Abbott.

The conduct of the focus groups was led by Stefanie Goeman (SG) and Marina Di Gregorio (MDG) with overall supervision provided by Annelien Dankaerts (AD), currently completing her PhD in the field of antibiotic treatment failure at the KU Leuven after completing her master's degree in Biomedical Sciences. Three focus groups were conducted in Dutch led by SG, a female general practitioner in training, also completing her thesis within the field of antibiotic treatment failure. One focus group was held in French, led by MDG, a female postdoc at the University of Liege with a master's degree in Biomedical Sciences.

Each focus group had a structured approach beginning with an overview of the purpose and rationale for the focus group, followed by the signing of the informed consent forms and the participants briefly introducing themselves. The subsequent discussion then systematically addressed several key topics. These included: 1) prior experiences with CRP POCT devices, 2) the facilitators and barriers to their use, 3) the installation and organization of the devices and the feasibility of their integration into clinical practice, 4) the experiences with technical issues and the point of contact and procedures in those situations and 5) the contexts in which the devices were used in general practice.

The four focus groups were audio-recorded and subsequently transcribed verbatim using Amberscript. The three Dutch focus groups were transcribed by Frauke Willemsens (FW) and Lauren Vermetten (LV), two GPs in training completing their thesis in the field of antibiotic treatment failure supervised by AD and Professor Dr. Jan Verbakel (JV). MDG transcribed the remaining focus group in French, considering she had led this focus group and speaks French as a mother tongue. Afterwards, the transcripts were translated into English using an online translator, Deepl.

We conducted a reflexive thematic analysis of the transcripts to identify and interpret patterns within the collected data. We followed the framework as outlined by Braun and Clarke (52). Data analysis

was conducted using QRS NVivo software (version 14), which facilitated the systematic coding and organization of the collected data. All transcripts were systematically reviewed and coded with the cooperation of five researchers (AD, MDG, SG, FW, LV). A systematic division of labor was used with a rotation approach so that each researcher was assigned to the different tasks at least once during the analysis of the four focus groups. Only AD remained in the same position while analyzing the different focus groups. One researcher was assigned to be first coder, which involved going through the blank transcript line by line and encoding it in NVivo by identifying meaningful segments and assigning these to a specific code. The second coder started from the coded transcript of the first coder and compared whether the codes assigned to the shaded pieces of text matched with their analysis and ideas, noted differences and comments and added or removed additional codes if necessary. AD acted as a third independent coder for each focus group coding and processing each transcript independently from the first two coders. Afterwards, she compared her work with that of the first two coders to highlight differences and/or similarities. Two researchers were assigned to reread the transcript with the goal of analyzing which elements stood out and/or could be important for further analysis separate from the three initial coders. For each transcript, all researchers independently made a draft of possible themes after the coding process. This involved brainstorming about combining different codes into overarching themes.

After individual analysis of every focus group, a meeting was held to discuss the coding and relevant themes. The last meeting focused on collecting and selecting the final themes that would be used in the final scription written by AD and MDG, supervised by JV (53).

After the final thematic analysis, a participant check was carried out by FW and LV in which participants of the different focus groups were asked to give their opinions on the final selection of themes derived from their input through an online questionnaire. In this questionnaire, the participants were asked to indicate the extent to which they agreed or disagreed with the final derived themes using a six-point Likert scale with response options ranging from “completely agree” to “completely disagree”.

Simultaneously with the conduct of the focus groups, an online survey was carried out in which participants were asked to give their opinions on various statements regarding the use of CRP POCT in daily practice. In the survey, a seven-point Likert scale was used, with response options ranging from "completely agree" to "completely disagree”. The results of this survey were manually processed by FW and LV in the form of a table.

Reflexivity statement

FW and LV, the authors of this master's thesis, are both female GPs in training in Flanders. They were both born and are currently living in the province of Antwerp in Belgium. In her prior clinical experience, LV never used a CRP POCT device, unlike FW. Given their professional background and prior clinical experience, their insights and views on the implementation of CRP POCT may be driven by practical clinical beliefs and observations. This contrasts with AD and MDG who are both females with a background in biomedical sciences whose insights come more from a primary research-driven perspective. Both FW and LV had no prior relationships or professional contacts with any participants of the study. Additionally, they also did not have any personal or professional links to either the companies involved in delivering the CRP POCT devices or the laboratories involved in the study.

Prior to the writing of this master's thesis, LV did not have any experience with qualitative research unlike FW. Nevertheless, she followed lectures and read relevant literature prior to the start of this qualitative research to be sufficiently grounded in the subject matter.

Both FW and LV acknowledge that their own clinical background, professional experiences and assumptions as a general practitioner in training could influence the interpretation of the results, increasing the risk of bias. To minimize this potential risk, certain things were kept in mind during the research process. Throughout the whole analysis, we kept track of our individual perspective on certain topics driven by our work as a general practitioner in training. We communicated transparently and openly about these personal perspectives so that we were actively aware of how our own beliefs could influence the interpretation of the study results. By self-reflecting and documenting these beliefs, we were able to interpret the study results separately from our own beliefs. Secondly, the usage of a mixed methods study design made it possible to check certain findings in both qualitative and quantitative data which reduced the risk of interpretation bias. During the analysis of the focus groups, we used systematic coding procedures and the formed codes were reviewed by other researchers to ensure that the final themes emerged from the collected qualitative data and not from assumptions made by the coders. Finally, we tried to use neutral phrasing throughout the whole coding and writing process to minimize the influence of our own beliefs and expectations on the written data in this master's thesis.

3. Results

108 stakeholders were contacted, of whom 58 were interested in participating in the focus groups. 37 stakeholders confirmed their participation of which 32 ultimately participated. Among the participants were 19 GPs, 1 GP in training, 5 company representatives and 7 professionals from the laboratories concerned (*Table 1*). Reasons for non-participation are shown in *Table 2*.

	Focus groups N (number)	Survey N (number)
Gender		
Male	10/32	12/39
Female	22/32	27/39
Age (years old)		
20-30	5/32	11/39
31-40	6/32	11/39
41-50	13/32	10/39
51-60	4/32	4/39
60+	4/32	3/39
Clinical experience (years)		
0-5	5/32	12/39
6-10	4/32	7/39
11-20	6/32	7/39
21-30	2/32	8/39
30+	3/32	5/39
Not applicable	12/32	0/39
Specialty		
General practitioner	19/32	39/39*
GP trainee	1/32	-
Representatives of the lab	7/32	0/39
Representatives of the CRP POCT manufacturer	5/32	0/39
Practice setting		
Group practice (2 or more doctors)	20/32	39/39
Solo practice	0/32	0/39
Not applicable	12/32	0/39
Degree of urbanization		
Rural	0/32	-
Town-suburb	16/32	-
City	4/32	-
Combination	0/32	-
Not applicable	12/32	-
Native language		
Dutch	22/32	37/39
French	10/32	2/39

Table 1: characteristics of participating stakeholders

*All survey respondents were GPs; no information was collected on training status. 11 survey respondents were aged 20-30 years, which may indicate the presence of GPs in training.

Reason for non-participation	Number of participants
Scheduling conflicts	3
Personal reasons	1
Prior focus group participation	1

Table 2: reasons for non-participation

Each of the four focus groups had between 6 and 12 participants (*Table 3*). The duration of the focus group discussions varied between 29 and 71 minutes, with an average of 53 minutes.

	Date	Location	Number of participants
Focus group 1	17/01/2024	Aalst, Department of laboratory Medicine AZORG	9
Focus group 2	05/03/2024	Brussel, Medibois Medical Center	12
Focus group 3	11/03/2024	Aalter, Medical Laboratory Medina	10
Focus group 4	27/03/2024	Aalst, Department of laboratory Medicine AZORG	6

Table 3: overview of the different focus groups (date, location, number of participants)

The comprehensive thematic analysis yielded four major themes. Within these themes, sub-themes and sub-sub-themes were established to structure and group the most important ideas logically. *Table 4* provides an overview of the themes, the sub-themes and the sub-sub-themes. Details of the coding tree and quotes in the original language are provided in the additional files.

Themes	Sub-themes	Sub-sub-themes
Theme 1: CRP POCT is an objective tool that reduces diagnostic uncertainty	Usage of CRP POCT to objectively complement clinical findings in situations of diagnostic uncertainty	
	Usage of CRP POCT to help convince patients	
	Possible other indications for CRP testing	Usage in pediatric population
		Usage outside the GP practice
Theme 2: Easy to use CRP POCT with reliable support integrates well in existing workflow	Easy to use CRP POCT	Overall ease of use
		Duration
		Required blood volume
	Integration in the existing workflow	Installation and location of the device
		Multitasking to integrate CRP POCT in the existing workflow
		Moment and person performing CRP POCT
		Administration
	Technical problems and support systems	
Theme 3: CRP POCT supports decisions and strengthens patient communication, fostering antibiotic stewardship	CRP POCT as a supportive tool in decision-making for GPs with added value for patients	Supporting the GP in clinical decision-making
		The influence of CRP POCT on general blood tests
		Potential pitfalls to consider for GPs in using CRP POCT to guide clinical decisions
		CRP POCT as a tool to initiate co-consultation
		Added value for patients
	The impact of CRP POCT on antibiotic prescribing by GPs	
	CRP POCT as a tool to facilitate and/or enhance doctor-patient communication	
Theme 4: GPs expressed concerns regarding costs and reimbursement of CRP POCT	Financial considerations and concerns regarding reimbursement	

Table 4: overview of all themes, sub-themes and sub-sub-themes

3.1 Theme 1: CRP POCT is an objective tool that reduces diagnostic uncertainty

3.1.1 Usage of CRP POCT to objectively complement clinical findings in situations of diagnostic uncertainty

According to the focus group discussions, CRP POCT serves as a helpful tool to objectify clinical findings of general practioners. They claim that it can serve as an extra objective argument alongside clinical and anamnestic assessment.

> *F2P10: "And our profession is completely based on probabilities, on experience, on anamnesis, on the clinic. And there's nothing we can do about it, machines like this must become indispensable."*

However, when anamnestic and clinical examination were clear, most participants did not use CRP POCT.

> *F3P2: "If it is clearly reassuring, you're never going to use it, if it's clearly not OK, you're not going to use it either, it is a bit in that gray zone indeed."*

It was emphasized by the participants that CRP POCT results should always be interpreted alongside the clinical context. Many stated that clinical assessment remains paramount, with CRP POCT serving primarily as an adjunct in situations of persisting diagnostic uncertainty. It was mentioned that doctors should remain cautious not to become dependent of CRP values for their decision-making.

They often referred to this diagnostic doubt as the 'gray zone'. Given examples of diagnostic uncertainty were ambiguous lung auscultation, doubt between a viral or bacterial cause of infection, a very sick patient with a normal clinical assessment and doubt whether outpatient or inpatient follow-up is desirable.

> *F1P1: "I still do the test to reduce my differential landscape, or my diagnostic landscape after all."*

> *F1P8: "I think, if you have someone with you on a Friday evening or in the evening and you are in doubt [...], what should I do now? Send to A&E or not? That that can also be a huge added value."*

> *F3P1: "If in doubt viral or bacterial. If really in doubt about [...] with clinical examination: is it a surinfection here or is it a viral infection after all."*

Some GPs pointed out that young doctors are keener to use CRP POCT, because they experience more diagnostic uncertainty and lean less on intuition. A starting GP even admitted he/she sometimes used CRP POCT as a tool to challenge his/her own clinical judgement.

> *F3P2: "And I also found it as a starting GP sometimes a bit of a test for my own clinical research. When I heard crepitations or something like that [...], then I would have started antibiotics earlier without the CRP device and then I sometimes found it interesting to add an extra parameter so objectively."*

> *F1P8: "If I compare with the GP in training, [...] she started as HAIO on October 1st, so she actually started with the presence of a CRP device and I have been working without a CRP device for 20 years. So I do notice that she would immediately follow this up much more."*

3.1.2 Usage of CRP POCT to help convince patients

GPs mentioned not only using CRP POCT as a tool to support their decision-making, but also to help convince patients. Given examples were convincing patients to go to the emergency department and to start/withhold antibiotic treatment.

Several participants highlighted that this reason to perform CRP POCT is influenced by the patients' perception of illness, as some patients seek more additional interventions or display a stronger insistence on starting antibiotics.

> *F3P3: "In itself yes, it is handy ... [...]. With people who are fans of antibiotics (laughs) [...], easier to convince [them] [...] or having something objective."*

> *F3P8: "[...] Also a little bit of diagnostic uncertainty within that particular case. That patient actually didn't want to go to A&E and I actually didn't feel that good and that then gives me an additional feeling of 'yes okay I'm right after all' (many confirm with 'yes' or uhum)."*

3.1.3 Possible other indications for CRP testing

Several participants mentioned additional indications, beyond the primary scope of this study (acute cough in adults), in which CRP POCT was considered useful. Reported examples included suspected diverticulitis, appendicitis, pyelonephritis and tonsillitis, mainly to assess whether reference to the hospital or initiation of antibiotic therapy was necessary.

The incentive to do CRP POCT was sometimes merely follow-up of the patient, where participants wanted an objective value that they could compare at a next appointment.

> *F2P12: "We've also used it for cough follow-up, because ... here's the acute cough and also the cough we've seen two or three times with a CRP that was evolving, and I find that interesting too."*

a. Usage in pediatric population

In pediatric patients, CRP POCT was regarded as an elegant tool and added value by many participants. Venous blood sampling comparatively was perceived as more invasive and potentially traumatic. Another frequently mentioned reason for performing CRP POCT in children was the perceived difficulty of clinical assessment in the pediatric population. Clinical assessment was often described as less straightforward and associated with lower diagnostic confidence among GPs, causing them to start more antibiotics.

> *F1P6: "With children too, because taking blood samples from children is something I hardly ever do myself. So in that respect it is elegant. It's not pleasant either, but it can't be compared to a real blood test. It works, almost always. When taking a blood sample from a child, you can already encounter problems if it doesn't go well or if [the child] doesn't lie still and is very difficult. That can be traumatic, so I think it really adds value."*

F3P2:"[...] I think also just really often antibiotics are given in children just because of that diagnostic uncertainty and surely you don't want to miss something in a child [...]."

F3P7: "[...] And with children it can also go two ways I think, a super sick child with [...] a CRP that is negative or a child where you think, it's still okay and then suddenly [...] a super high CRP because clinical [assessment] is very often more difficult in a child (several confirm). [...]I think that's where the greatest added value lies."

Furthermore, participants considered CRP POCT at a GP practice as more accessible than a test at the pediatrician. They also assumed that patients with children often visit the pediatrician purely for the CRP test. Being able to do this themselves is therefore an added value in primary care.

b. Usage outside the GP practice

One participant reported having access to a CRP device in a nursing home setting, although he mentioned that the test was rarely used in this context.

In out-of-hours care facilities on the other hand, many GPs already used the device, with some even considering it as an indispensable part of the equipment on guard.

F1P8: "I also see it being used at more and more emergency [departments]. I know that at our guard station there is also a device, where that is nevertheless regularly [used], I'm not saying by everyone [...] and I think that actually that should start to become an indispensable part of our equipment."

During home visits, some GPs also used CRP POCT. The device that needs more blood and therefore solidifies later, was perceived as the most useful in this context.

3.2 Theme 2: Easy to use CRP POCT with reliable support integrates well in existing workflow

3.2.1 Easy to use CRP POCT

a. Overall ease of use

Most participants appreciated the overall ease of use of CRP POCT, with some variation between the different types of devices. The sampling method of certain devices was perceived more difficult, but most confirmed to have adapted to each device over time. Several even mentioned CRP POCT being an added value and integral part of their practice, noting that they would miss it if it were no longer available.

F3P1: "Yes, super, all user-friendly (several people confirm with 'yes')."

F4P2: "I wished I already had those quick tests and when that device got there I was totally happy (laughs). So I can't live without it anymore because that's a bit of reassurance if you're stuck somewhere that you can do something."

F1P1: "Yes, [we] had the CRP device with us and I found it a huge plus to have. I will miss it when it is no longer there."

In general, the device was reported to be frequently used, partly because of its convenience and partly because of the mere availability. Only a small number of GPs mentioned performing relatively few tests and anticipated limited future use of the device.

b. Duration

The turnaround time of the test was highlighted by several participants as the most important feature, with notable variation between the different types of devices. The availability of results within a few minutes helped quick clinical decision-making on the spot. According to one GP, the speed of the test was also appreciated by patients not having to wait another day for the results.

> *F2P12: "What we found very interesting was having the results immediately. We were talking about Friday evening, but even on Monday evening, we take the sample at 5 p.m., send it to the laboratory, some laboratories may be on the ball, let us know at 9 p.m., and then we have to contact the patient again. It's complicated, but now that we have the information directly, we can also look at the patient's follow-up in a completely different way. So I think it's really very useful."*

> *F4P1: "The only thing you have no influence over of course is the turnaround time of your [...] device. You can be very fast in taking it and get better at that but of course, [you can] never train the device to pass its test faster than it needs time. I think that's an important factor."*

> *F1P1:"So and the patient also experiences that as very positive that [the result] is also known immediately. That they don't have to wait until the next day for their result, or so they say."*

One participant, however, found the test interruptive to the consultation flow, despite its rapid turnaround time.

> *F2P2: "I think that even if these tests are extremely fast, interrupting a consultation, taking a sample and waiting for a result, even if it's not very long, is still in.... a busy consultation, it's still time that's wasted in inverted commas."*

c. Required blood volume

The required blood volume was regarded as another important characteristic of the device. A smaller sample volume was generally perceived as more practical, especially in pediatric patients. However, these smaller volumes were more prone to errors related to blood solidification, necessitating faster sample handling.

> *F4P2: "La Roche it was. I found that the hardest. I was just constantly fiddling with that myself. And that's going to stop me from using it. ...whereas if you just have to take a little drop, that's a bit cleaner. And yes, it could also be just me, but I didn't find that very easy."*

> *F1P1: "[...] I think you might have less blood, especially with children. [...] Now it was mainly aimed at adults [...], you could push on that finger once, you could push again. With a small child that might be less interesting."*

Some considered larger samples as an advantage, as they rendered an extended storage time, which was proven to be useful during home visits. On the other hand, devices requiring larger volumes were considered more challenging by some participants, as insufficient samples resulted in error messages more often.

> *F1P8: "One needs less blood, the second requires a bit more handling maybe, but you can then keep it [...] even longer and take it with you on the track. I think that's also an advantage."*

> *F3P7: "The downside is with you guys, you certainly can't leave that for super long or it will solidify. Usually you analyse immediately anyway. [...]"*

3.2.2 Integration in the existing workflow

a. Installation and location of the device

The installation of the device proceeded smoothly in all practices and any issues were quickly solved by employees of the companies or laboratories. Most participants preferred the device to be in a central area, accessible to all doctors without causing disruption. Alternative locations included the secretarial office, with the nurse or in a consultation room. Especially a CRP device in one of the consultation rooms was experienced as disruptive to ongoing consultations.

> *F3P3: "I think that having space for it is important. The common space, that everyone can get to it without disturbing anyone [...]."*

> *F1P9: "At our place, the CRP device is also in one of the cabinets which maybe also caused us to use it less, because you don't want to disturb the other one [...]."*

When the device was not located in a common area, participants often called for results (to the secretary, nurse or other doctor) to prevent wasting time.

b. Multitasking to integrate CRP POCT in the existing workflow

While awaiting the test results, most participants reported trying to multitask, this way integrating CRP POCT in their existing workflow. Given examples were: discussing subsequent steps with the patient, explaining and/or convincing about (no) antibiotic use, explaining alarm symptoms or completing administrative tasks (e.g. certificates, prescriptions). Therefore, the waiting time was generally not perceived as a disrupting or prolonging factor to their consultation.

> *F1P1: "[...] You did your tests in the meantime... [...] I already had to prescribe something else from antibiotics [...], I had to prescribe something else from medication. There are other things though or their attestations for the work you are making. And by then the test is known."*

> *F1P8: "I usually did that myself during the consultation and ultimately most of the tests – what is that, you have the result in two or three minutes, so I certainly don't think it's worth putting them in the waiting room until the result is known or having the nurse do it. I think it's something you can do very quickly in between other things. [...] I think you spend more time discussing with the patient why they do or do not need antibiotics than it takes to get the test results."*

c. Moment and person performing CRP POCT

The majority of GPs did the test themselves, after anamnesis and clinical examination. However, a few participants delegated the performance of the test to a nurse or intern.

Some specified that, if the decision to perform CRP POCT was made later during the consultation, it sometimes resulted in an extension of the consultation duration, as no further discussing or tasks remained during the waiting period. One GP occasionally solved this problem by already starting a consultation with another patient during the waiting period, requiring the initial patient to wait in the waiting room until the result was available.

> *F4P2: "With me always after the clinical examination, ... I did always do the clinic first and then if I had any doubts [...], then indeed a CRP."*

> *F4P1: "Sometimes also really at a later [...] time. That of course meant that the consultation sometimes dragged on a bit because, of course, the earlier you do it, the more it can fit into your consultation."*

d. Administration

In some practices, an automatic linkage between the device and electronical medical record (EMR) was available through a barcode system. Other participants had to manually communicate the CRP results to the laboratory, after which the results appeared in the lab results the following day.

Almost every GP recorded the CRP results in the consultation notes of the EMR, regardless of the linkage to the EMR. Participants generally found writing the result in the notes most practical. However, some participants preferred the results to be integrated in the EMR for easier access alongside other test results.

> *F1P5: "[...] It was nice that it comes in [the EMR], but indeed it doesn't necessarily have to, because indeed we note it down and then you can take it out of your package. If you code it that way, then you can take it out. So [...] [it is] not that I don't find the work useful, but [...] I don't mind it either. I wouldn't have missed it if it hadn't been there."*

> *F3P7: "It's more convenient I think. If you can choose that it does appear with your other lab results and that you see it in the set of parameters."*

It was also mentioned that a broader integration of the CRP result in the health network could help passing on information to the second line (e.g. hospitals, emergency department).

3.2.3 Technical problems and support systems

Several participants reported experiencing few or no technical problems. Others, however, described encountering error messages, which were sometimes device dependent. While some did not mind repeating the test – since patients generally accepted an additional finger prick – others perceived this as time-consuming and potentially disappointing for patients.

> *F1P9: "For us, we have actually not been able to measure much with the last device because we had problems with it because we often got error messages. It is of course also device dependent."*

> *F4P1: "[...] I think that we didn't really experience obstacles or things in using the device. No, no absolutely not."*

The location of the CRP device was also perceived to affect performance: devices seemed to dysfunction in conditions that were too warm or too cold. Additionally, problems of connectivity with the electronical medical record were reported by some participants.

When technical issues arrived (e.g. problems with connectivity), most participants send an email or called the lab. This technical support was generally regarded as prompt and useful. Only few participants mentioned having to wait several days for the replacement of a device or the delivery of new test strips. Some participants furthermore doubted whether this quick problem solving would still be possible if CRP POCT became implemented on much larger scale.

> *F3P9: "I usually passed it on to our secretary and then she sent an email. I think it was sent to the clinical biologist and we always got a quick reply with good instructions. I also think that at one point we had a problem with our device, because it was under the blower of the heater, that it overheated slightly, and we immediately got another one [...]."*

> *F2P10: "Firms are very responsive, let's be honest. It's impressive. They have the resources, they have staff who are very responsive. Frankly, I still use a device. When I have a problem, I send an email. I get an answer very quickly. "We're on our way" or frankly, it's..."*

To combat technical problems and ensure a reliable CRP result, it is necessary to perform quality controls on a regular basis, according to several clinical biologists and laboratory employees. However, not every practice performed those. Some had support from the laboratory, others had to carry them out themselves or delegated it to the secretary. It was perceived as annoying and often forgotten by some GPs because it takes time and because it is not financially rewarded. Some participants mentioned that it could be useful if the equipment gets blocked each time when a quality control is needed, so it is not forgotten.

> *F3P7: "Quality control products are also really not cheap, for example. You might pay 150 euros for 1 box, but in the end you won't get anything out of it. I think this is also an important, practical point in the implementation."*

3.3 Theme 3: CRP POCT supports decisions and strengthens patient communication, fostering antibiotic stewardship

3.3.1 CRP POCT as a supportive tool in decision-making for GPs with added value for patients

a. Supporting the GP in clinical decision-making

CRP POCT can provide confirmation of the GPs' gut feeling or intuition in certain cases where they are confronted with an unpleasant gut feeling or with a doubt about whether a serious infection is present. CRP POCT serves a supplementary role considering that the clinical assessment of the patient remains the cornerstone of primary care.

> *F4P1: "... and on the other hand sometimes in borderline cases where that I clinically feared a bit [...] for a serious infection [...], an exclusion or a confirmation [...] of my clinical sense or of my clinical assessment."*

> *F2P5: "And at clinical level, [...]. I think it gives us something very objective. In general practice, it's true that we're very good at gut feeling and clinical examination, ... and also to really feel a little how people feel, and that allows a certain objectification of things, depending on the CRP."*

The results of CRP POCT were also used to reassure the GP in certain specific cases about the absence of a (serious) infection, thereby supporting clinical decision-making during the consultation.

> *F4P2: "[...] But also the other way around as my colleague said, it also reassures you a little bit somewhere of there is no infection at all and it's okay..."*

Sometimes, the result of a CRP POCT was surprising, and this occurred in both directions. A person could appear very sick clinically, but the CRP value turned out to be low or a person could appear clinically fine but had an unexpected very high CRP value. This was seen as an added value, especially in children because clinical assessment was considered more difficult in children as mentioned in theme 1. The surprising results made early intervention possible, and one GP even said that thanks to the presence of the machine, mismanagement of 2-3 cases was avoided.

> *F1P8: "[...] It is indeed you sometimes scare in the two sides that you think [...] this won't be too bad but we'll still check once, because it already takes a bit longer for example and then you have a sky-high CRP. But also vice versa that you have someone with you that you say, he is really sick to death right now and that it's not that bad and thought, okay."*

> *F1P8: "And sometimes you get surprised, you get scared. I have had cases where I thought, okay, this is not too bad and then you have a CRP of 150. Otherwise you see those people back two days later or you have to admit them. So I think that's a big condition."*

> *F2P10: "[...] Thanks to the machine, there have been two or three cases where I haven't missed something."*

b. The influence of CRP POCT on general blood tests

An interesting topic raised regarding the consequences of using CRP POCT to guide clinical decisions, was the influence of CRP POCT use on whether or not to perform general blood tests. One GP said that CRP POCT could result in more lab tests because it will sometimes lead you to certain differential diagnoses where you want to know some additional values like white blood cells, ...

> *F2P10: "And I think that brings more lab testing than less lab testing. [...] Because it will sometimes lead you to have a diagnosis that will perhaps lead you to do some extra white blood cells or some extra tests [...] ..."*

Several GPs said that they sometimes took a general blood sample after the CRP POCT finger prick if they wanted additional specific testing based on the CRP value. It was mentioned that patients generally had little difficulty with this if it was explained properly. One GP even did a venous blood sample and performed the CRP POCT test with blood from one of the tubes, providing him with an immediate CRP value while sending the rest to the laboratory for additional testing.

> *F3P2: "Yes, that's also a matter of explaining to your patient that it's so high, so I want further information, or it's lower than I thought and I don't know what it is so I would still like to look further. But I think people never blame us [...], if we say we want further information."*

> *F2P5: "[...] Sometimes I'd take blood samples and I'd take [the blood needed for the CRP POCT] from the green tube. I'd do the test directly, and that was also [...] very interesting, because I'd get my CRP directly, while sending the rest to the lab to get everything else and in fact I found that super useful too."*

c. Potential pitfalls to consider for GPs in using CRP POCT to guide clinical decisions

An important caution is the possibility of false reassurance that was mentioned during the focus groups, illustrated by some specific cases. Therefore, it seems important to make agreements with the patient about follow-up after the index consultation, because GPs should not be blinded by one CRP value and must continue to pay attention to the clinical picture and its evolution. Subsequently, the reliability of the CRP result was linked to the moment of assessment during the disease process by a participant, where the CRP can still be negative and/or low in the early stages of a potentially serious infection.

> *F1P1: "Maybe still one afterthought but it's just been, I think, very case-specific. We had a patient who seemed very, very sick, in retrospect probably was very sick. But the CRP actually falsely reassured us at the time. We then measured a CRP of less than three, but unfortunately she was admitted two days later with septic shock with pneumonia on influenza [...]. But maybe I think [...] it was just for us a bit more of a confirmation of oh no it's really okay, while that may have falsely given that impression."*

> *F1P8: "You do find out that someone who is very ill can still have relatively low CRP and that you have to make an agreement with the patient that if you become really ill, then you have to get back in touch."*

F3P2: "It is sometimes (gasps), all the time, that the clinic is still (laughs) important, of course, and the follow-up, because you can still have a normal CRP at an early stage, and then it goes up anyway. We shouldn't blind ourselves to it or anything [...] (people confirm muttering)."

F4P2: "The moment you are going to determine a CRP too, the moment of the disease. And if you do it too early, you are actually still not sure if it's okay then. So I think it's useful, especially for a long-lasting cough, but an early cough or fever, it is not very useful."

There also appeared to be considerable confusion among the participants regarding the interpretation of the CRP value and the lack of evidence and/or guidelines regarding CRP thresholds. Some GPs followed the NICE guidelines with thresholds of 20 mg/L and 100 mg/L while other participants admitted having used other thresholds. Especially values in the gray zone (between 20-30 and 60 mg/L according to the participants) were perceived as annoying and difficult to interpret.

F3P7: "I actually don't know officially what the cut-offs were that were supposed to be used."

F4P2: "[...] If it's nothing like that's good, and if it's a lot it's also good. But something between the two is annoying."

When it comes to using CRP POCT to convince certain patients that they do not need an antibiotic prescription, some GPs warned that this should not be the only reason for performing the test in daily practice.

F3P2: "[...] But still I feel that now that can be a tool somewhere to, they then have this kind of thing. They like to have something objective in their hands sometimes [...] and then it does help right away, but apart from that, [...] indeed it's not the intention that we have to do it only for that (unintelligible)."

d. CRP POCT as a tool to initiate co-consultation

During the focus groups, GPs indicated that CRP POCT facilitated collaboration between physicians, which the GPs found very interesting. A given example was a case with discrepancy between the measured CRP value and the patients' clinical presentation for which the advice and input of a colleague was requested with the aim of reaching an informed decision together.

F2P12: "Well, in other words, my colleague was doing a test, she had a test that was doubtful [...], she had 27 and still found that the patient wasn't very well, so 'can you come and listen?', 'give me your opinion?'. I found that very interesting."

e. Added value for patients

In addition to the benefits of CRP POCT use for GPs, certain benefits for patients were also highlighted during the focus groups. First of all, there is the immediate availability of results during the consultation meaning that patients no longer have to wait until the end of the day or the next day to get their results and the associated therapy. CRP POCT also acts as an objectifying tool for patients, thereby providing reassurance that the GP is making the right call, taking away the doubts that sometimes remain when no additional tests are conducted by the GP.

F1P1: "The patient also experiences that as very positive that that is also known immediately. That they don't have to wait until the next day for their result, or so they say."

F2P3: "Can I take the patient opinion? No, but it's really interesting to hear what you have to say. Because I'm more on the patient side, and I find that really reassuring, because we know that a doctor doesn't have absolute knowledge and can't always be sure, not in all cases in any case. So when you're on the patient's side and the doctor's opinion is corroborated by a small CRP, it's extremely reassuring that, yes, you're not going to take antibiotics for nothing. [...] From the patient's point of view, I find it really very interesting."

F4P2: "That also helps people to then go home with a peace of mind or something and also have the feeling of the doctor did the right thing and have no more doubts."

From a clinical point of view, CRP POCT also has indirect valuable benefits for patients through the possibility of early intervention during the disease process, avoiding hospital admissions and preventing unnecessary antibiotic prescriptions. This could reduce antibiotic resistance, as mentioned by several participants.

F4P1: "By avoiding hospital admissions, or by taking action earlier in certain cases. Or conversely by avoiding antibiotic resistance or antibiotic prescriptions..."

3.3.2 The impact of CRP POCT on antibiotic prescribing by GPs

The CRP value generated by CRP POCT helps GPs to determine whether or not to start antibiotics leading to fewer (delayed) antibiotic prescriptions, according to different GPs. This is in contrast with the expressed concern prior to the study about potential high CRP values and therefore the need to start antibiotic treatment earlier, resulting in more antibiotic prescribing.

F1P8: "I also think it has a condition that you give much less delayed antibiotic prescriptions now. I didn't do that much either because I don't believe in it very much. But indeed, if you have someone on Friday and you have a CRP that's really low and it's not that someone is deathly ill, then I think you're less likely to give a delayed prescription than if you don't have a value [...]."

F4P2: "So especially the idea of, that person is coughing and that cough doesn't sound so okay, but we don't hear that much clinically. That was pretty much an addition to know [...], is that here still postviral or is that here really still something atypical that could be behind it. So that did help me a bit in choosing whether to start antibiotics or not. It did make me prescribe less antibiotics especially [...]."

It can also help to convince patients more confidently that antibiotics are not necessary, especially when patients themselves request an antibiotic prescription.

F1P3: "[...] For my diagnostic doubt on the one hand and sometimes to be able to convince the patient of the non-necessity of antibiotics then (laughs)."

A young, starting general practitioner stated that she would have started antibiotics earlier without the CRP device (cfr. supra).

F3P9: "and I also found it as a starting GP sometimes a bit of a test for my own clinical research. When I heard crepitations or something like that [...], then I would have started antibiotics earlier without the CRP device and then I sometimes found it interesting to add an extra parameter so objectively."

One of the participants mentioned the use of CRP POCT as a way that can help achieve the national targets set for antibiotic prescriptions, thereby battling the problem of antibiotic resistance.

F1P8: "Certainly if we want to meet our target, targets for antibiotics a little bit and get those prescriptions down. Yes, surely that's a way to do that in a more reassuring way, where both the patient and yourself are more reassured to say [...]: look, we're not going to do it. And also vice versa."

3.3.3 CRP POCT as a tool to facilitate and/or enhance doctor-patient communication

As shortly mentioned above, CRP POCT can serve as a tool to facilitate communication between GPs and their patients in different ways. According to a GP, providing a clear explanation in advance ('low means viral infection, high means bacterial infection') ensures that people have more confidence in the result of the CRP POCT and go home feeling reassured.

F1P1: "Also for your patient, if you explain very clearly beforehand: look, if it's low, it's viral, if it's high, it's bacterial and you come back and you say: look, it's low, then they have more confidence in it."

F4P2: "An that also helps people to then [...] go home with a peace of mind or something and also have the feeling of the doctor did the right thing and have no more doubts."

Convincing patients why antibiotics are not always necessary can be challenging and as previously mentioned, CRP POCT can play a supporting role in this regard.

F2P10: "And when you've got fifteen patients and by the sixteenth you've still got to fight, to tell him no antibiotics at some point, I honestly admit that there are times when I don't fight. So this machine is going to help me not to fight and is going to fight in my place. It's going to say "it's under 5, no discussion" and people are, as you say, convinced straight away."

One GP presented a case involving a patient about whom she had a bad feeling clinically, but the patient did not want to undergo further examinations through the emergency department. The CRP value generated through the CRP POCT confirmed her suspicion and ultimately, she was able to convince the patient to go to the emergency department for further examinations using, among other arguments, the generated CRP value.

F3P8: "[...] Also a little bit of diagnostic uncertainty within that particular case. That patient actually didn't want to go to A&E and I actually didn't feel that good and that then gives me an additional feeling of 'yes okay I'm right after all' (many confirm with 'yes' or uhum)."

F3P8: "And then I still managed to convince him (laughs) to go to A&E."

3.4 Theme 4: GPs expressed concerns regarding costs and reimbursement of CRP POCT

3.4.1 Financial considerations and concerns regarding reimbursement

During the focus groups, many GPs expressed concerns about the financial implications regarding CRP POCT in primary care in Belgium, because there is currently no provision for reimbursement. The current financial regulation regarding devices used outside of the study is described by the participants as a Wild West which calls for the development of a clear framework.

The purchase of the device itself was seen by one GP as a potential personal/practice investment but the GP should not have to pay for all the individual test cassettes because the costs would otherwise quickly mount up.

> *F3P2: "I think the purchase of the device I could see as an investment [because] [...] I think this is worth implementing, I don't necessarily think that should be passed on to the patient. But if each cassette is every time 5 euros [...], then [you are] already directly [looking at] a serious investment. And that makes me think: yes, is that actually for us to carry around?"*

> *F4P1: "[...] I think it would be useful should there be a refund system for it. That it would be a bit clear to everyone how that [...] it should be used. I think a lot of things are mixed up here. When I hear from colleagues who have a CRP device how that happens or whether or not it is reimbursed, I think a bit of everything happens. It's like a Wild West in that respect. So I think it would be better if there was a clear framework for that."*

A potential option brought forward by the participating GPs was to pass the cost of the test cassettes to the patient with suggested prices ranging from 5 to 10 euros. However, it is important to note that determining CRP levels via a general blood test is almost free of charge for the patient, making this a suboptimal solution according to several participants. Another concern was raised by a GP regarding the use of CRP POCT as a means to convince patients of the non-necessity of antibiotics when they insist on a prescription. He found it difficult to ask patients to pay for the test solely to prove that the clinical assessment was accurate and that antibiotics were therefore not indicated.

> *F1P5: "[...] I find it difficult when someone really insists on antibiotics and you make them pay for a test and then say: you see, I was really right. Yes, I find that difficult."*

People's willingness to pay for a technical procedure such as a CRP POCT was generally not considered a problem when properly explained. Overall, the participating GPs believed that parents would be willing to pay for their children to be tested in order to get quick results. This is believed to be in contrast with adults according to some participants, who would rather wait a couple of hours for the results of a general blood test from the lab rather than bear the additional cost of a quick CRP POCT result.

> *F2P10: "[...] Here, patients didn't have to pay so it was even more convenient for patients, but just to say that patients don't mind paying when they see what they've got [...]. People don't mind paying for a*

technical procedure, whereas it's harder for them to pay for an intellectual procedure. And so here they see the machine running in front of them, so there's no need to worry, which means that there's no need to worry about billing patients for those who want to use the machine afterwards."

F3P7: "On the other hand, I think that parents might be quick to pay for an immediate result (several confirm), except for a child they might do that, but for my own child I would pay immediately, while for myself I might say something like: let it go to the lab, which is covered by reimbursement and you have to wait a few hours or so for a result, but for your child who is immensely ill, if it costs fifteen euros or so, I think a lot of parents will want to pay that (many confirm)."

F3P7: "[...] Acute cough in adults [...] it's not the most urgent thing, you can wait 3 to 4 hours for a CRP from the lab. I think with your child[...] you can actually get results very quickly or whether you have to go to the hospital urgently or not. But such an acute cough in an adult, you can postpone the prescription [...]. I find that actually [a] somewhat less good indication for CRP POCT (several confirm), but [...] nobody here can do anything about it, but I find it less logical actually."

Another significant financial barrier concerns the requirement for quality control, as the materials needed for this process come with additional costs without providing a direct benefit to either the patient or the GP.

Mixed opinions were brought up about the broader economic impact of CRP POCT in primary care. On the one hand, one GP stated that the implementation of reimbursed CRP POCT would avoid a lot of unnecessary testing thereby reducing health care costs. Another GP on the other hand warned about the danger of performing unnecessary CRP tests when there is a financial benefit associated with performing the test. Caution was brought up about the possibility of creating overconsumption due to patients wanting repetitive tests when making CRP POCT in primary care free of charge. It was mentioned that patients' expectations may also change whereby they are less inclined to believe what you say and instead demand immediate objectification with a CRP POCT.

F4P1: "Yes because I think in itself it's certainly not [...] a financially heavy burden I think for the [...] health care. [...] I think it will certainly save us as much care as it would have cost us in a reimbursed context, let's put it this way."

F2P12: "I don't think there should be any financial advantage in carrying out a test, because having a financial advantage in carrying out a test means generating unnecessary tests."

F2P12: "[...] I don't mind paying for a test that I want to do to reassure myself that I'm taking good care of a patient, but I think that when you make everything free, you encourage the patient to consume."

In order to overcome this key barrier to wider implementation in the future, many GPs agreed that a solution is needed to cover the costs associated with performing CRP POCT in primary care. The options mentioned were passing on the costs directly to patients, reimbursement of the costs by the Belgian National Institute for Health and Disability Insurance (RIZIV/INAMI) or support by mixed insurance companies to cover the costs.

3.5 Survey results

The survey was completed a total of 93 times, of which 83 responses were complete. After duplicate analysis, these results were obtained from a total of 39 GPs. Those 39 GPs completed the survey for the different CRP POCT devices they worked with during the period of the study.

The figures below show the survey results. *Figure 1* represents all statements with full agreement and *Figure 2* all statements with (some) disagreement. As visually shown, the majority of respondents agree with most statements about CRP POCT being a reliable and accurate tool to support decision-making for GPs in daily practice. Opinions are rather divided on two propositions concerning the impact of CRP POCT on the duration of consultations ("The CRP rapid test can be performed without extending the consultation duration.") and the impact of CRP POCT on future consultations for the same complaints ("The CRP rapid test will reduce future consultations for similar complaints (e.g., cough).")

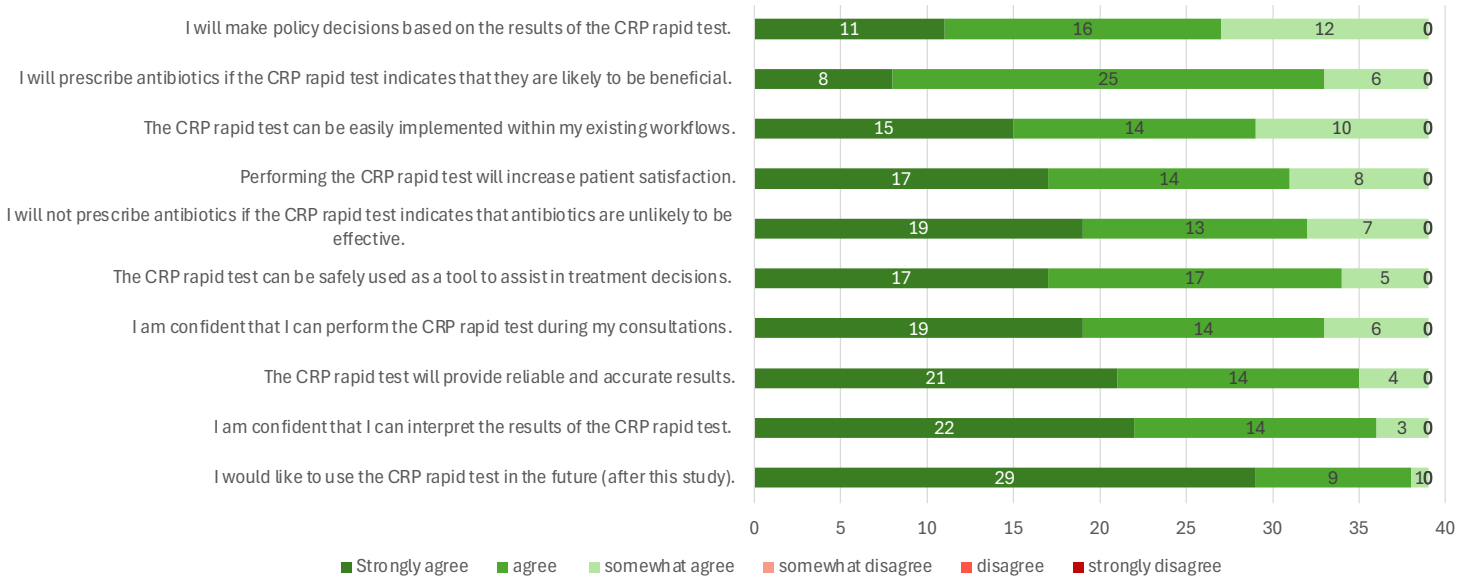

Figure 1: survey results: statements with full agreement

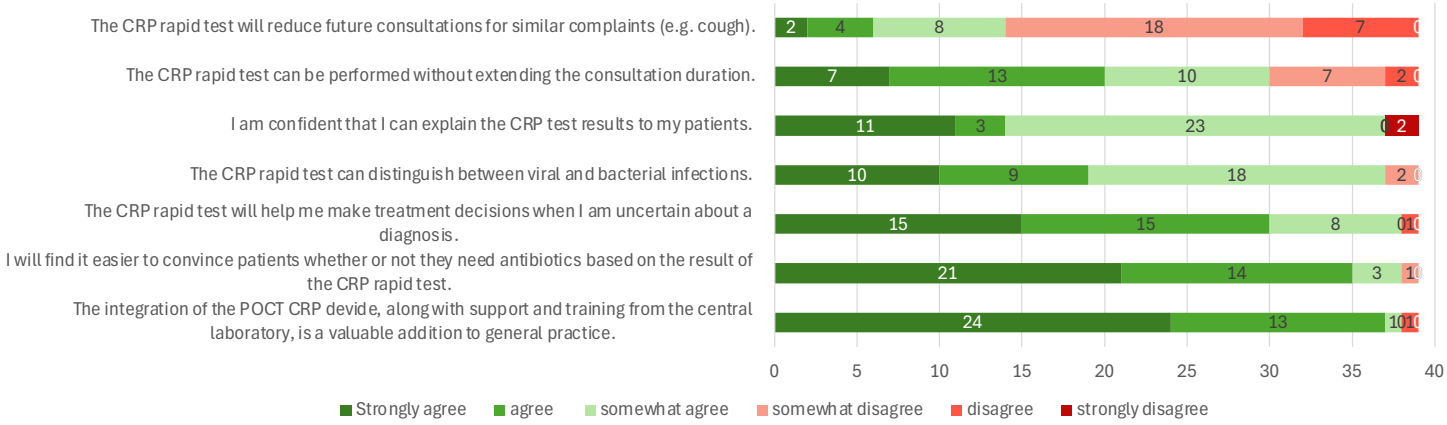

Figure 2: survey results: statements with (some) disagreement

The triangulation table below (*Table 5*) shows the comparison between the qualitative data collected through focus groups and the quantitative data collected through the survey.

Theme	Focus groups (qualitative)	Survey (quantitative)	Triangulation
CRP POCT is an objective tool that reduces diagnostic uncertainty	Objectify alongside clinical findings in case of diagnostic uncertainty Help convincing patients (antibiotics, referral to emergency department) Other indications: *Follow-up *Pediatric population *Outside of the GPs practice	All participants agreed (to some extend) that CRP POCT helps making policy and treatment decisions and that they can easily interpret test results. Almost all participants believed that a CRP test will help make treatment decisions in cases of diagnostic uncertainty (38/39) and helps distinguish between viral and bacterial infections (37/39).	Convergence: both sources of data show agreement about CRP POCT being an objective decision-support tool to reduce diagnostic uncertainty. Complementarity: the focus groups pointed out its possible usage for broader indications and its role in patient persuasion.
Easy to use CRP POCT with reliable support integrates well in existing workflow	Easy to use, rapid One found it interruptive to the consultation Smooth integration in existing workflow Technical problems were solved quickly by provided support systems Quality control was perceived cumbersome	All participants agreed (to some extend) that they can perform and implement the CRP test in their consultation workflow and that it provides reliable, accurate results. Most participants believed that CRP POCT can be performed without extending consultation time (30/39).	Convergence: easy to use and smooth integration in the workflow. Little disagreement exists about possible extension of the consultation time. Complementarity: interruption of consultations and quality control were highlighted in the focus groups as minor barriers.
CRP POCT supports decisions and strengthens patient communication, fostering antibiotic stewardship	Supportive tool in decision-making Surprising results Pitfalls: *False reassurance *Interpretation of the CRP value Tool to initiate co-consultation Added value for patients Less antibiotic prescribing Facilitate and/or enhance doctor-patient communication	All participants agreed (to some extend) that CRP POCT increases patient satisfaction. Almost all participants believed that they could explain CRP test results to their patients (37/39) and that CRP POCT makes it easier to explain whether patients need antibiotics (38/39). On the contrary most participants believed that CRP POCT will not reduce future consultations for similar complaints (cough) (25/39).	Convergence: both sources of data indicate improved decision-making and patient communication supporting antibiotic stewardship. Complementarity: the focus groups identified false reassurance and interpretation of the CRP value as potential pitfalls. The survey data showed no suspected reduction in future consultations.
GPs expressed concerns regarding future costs and reimbursement of CRP POCT	Concerns about financial implications	All participants were willing (to some extend) to use CRP POCT in the future. Almost all participants believed that integration the CRP POCT device, support and training by the central laboratory is an added value to general practice (38/39).	Dissonance: the focus groups showed financial concerns where the survey results mostly indicated a high willingness to use in the future.

Table 5: triangulation table

3.6 Participant checking

After thematic analysis, participant checking and corresponding feedback was obtained from 21 participants. The results indicate that they generally strongly agreed with the four main focus group themes derived from the thematic analysis as shown visually in *Table 6* and *Figure 3*.

	Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree
Theme 1	0	0	0	0	11	10
Theme 2	0	0	0	1	7	13
Theme 3	0	0	0	3	12	6
Theme 4	0	0	0	3	13	5

Table 6: participant checking results

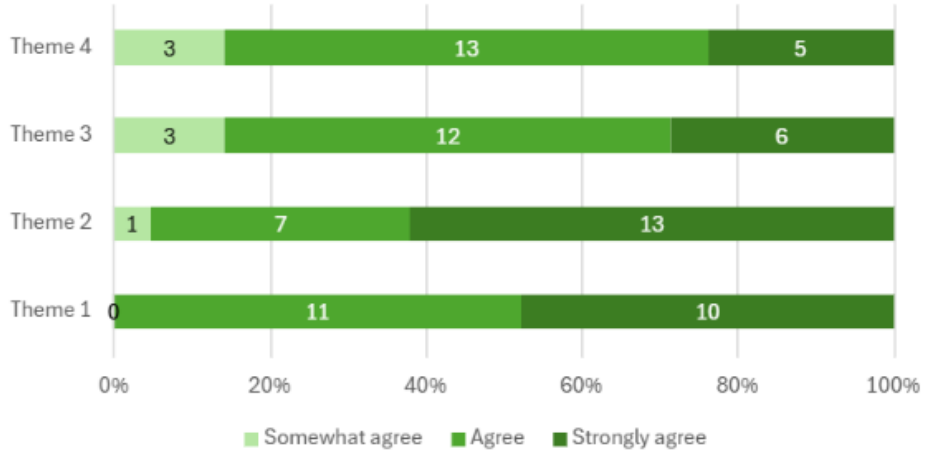

Figure 3: participant checking results

4. Discussion

4.1 Summary and interpretation of main findings

This mixed methods study aimed to assess the implementation of CRP POCT devices in Belgian general practices within the clinical context of adults with acute cough.

According to the participating GPs, CRP POCT serves as an objective tool in cases of diagnostic uncertainty and can support the GP in clinical decision-making but cannot replace clinical assessment as the cornerstone of primary care. It was pointed out that CRP POCT helps GPs to justify decisions, enhances doctor patient communication and supports shared decision-making, especially when expectations for antibiotics are high or referral decisions are difficult. CRP POCT also stimulated collaboration where discrepancy between the clinical presentation and the CRP value triggered co-consultation between participating GPs.

GPs themselves realize they must remain alert to potential false reassurance, the possibility of low CRP values measured in early severe infections and CRP values in the gray zone, given the fact no clear cut-offs have been defined yet. On the contrary, the GPs in the focus groups pointed out various advantages for patients such as immediate test results, objectification of the physicians' clinical assessment, reassurance and avoidance of hospital admissions and/or unnecessary antibiotic treatment.

The GPs involved also mentioned usefulness in other indications and in other contexts, such as nursing homes, out-of-hours care facilities and especially in the pediatric population, where the test is less invasive than a general blood test and clinical examination is less reliable.

Overall, CRP POCT devices were considered user-friendly, with a natural integration into the existing workflow. A rapid turnaround time and minimal blood sampling were considered as determining factors in convenience. Most GPs routinely documented the CRP results in their consultation notes of the EMR. Technical problems with the devices were generally experienced as non-significant, given the efficient support by the labs. However, these issues were sometimes considered time-consuming and potentially disappointing for patients. Some doctors described the recommended and necessary quality control tests as cumbersome.

There appeared to be widespread concern regarding the financial aspect of CRP POCT implementation in Belgian primary care, where there is currently no clear framework for managing costs and reimbursement. This may encourage overconsumption when using the CRP POCT device is linked to a financial benefit.

4.2 Comparison with existing literature

Existing literature confirms our findings, demonstrating that CRP POCT serves as an objective decision-support tool in cases of diagnostic uncertainty, with clinical assessment as the remaining cornerstone of the decision-making process (54–59). CRP POCT is proved to help shared decision-making, help regulate patients' expectations, and is generally appreciated by patients (57,60–63).

Evidence indicates that the use of CRP POCT can lower the number of antibiotic prescriptions and thereby help limit the development of antibiotic resistance (22–24,64). However, in pediatric populations, findings are inconsistent, with some studies showing a significant reduction in antibiotic prescriptions while others do not (23,45,65). The likelihood of a reduction appears to increase when cut-off guidance, a decision support system or communication skills training for GPs is provided (60,66–68). Currently, cut-off values vary across guidelines, highlighting the need for further research (29,42–44,69). Existing evidence demonstrates that excluding clinical assessment results in no significant change in prescribing behavior, despite the use of CRP POCT (22,23,46). In a similar qualitative study about CRP POCT implementation for adults presenting with ARI in primary care, GPs mentioned only using the test when clinical examination was equivocal. They also addressed concerns about overreliance on testing and ambiguous result interpretation (70).

Overall, other qualitative studies regarding the perceptions of primary care doctors confirm that CRP POCT is relatively easy to integrate in the workflow of GPs (62,70). The time needed for the testing process is widely mentioned as a determining factor for ease of use of CRP POCT (62,71–73). The importance of multitasking, the amount of blood needed for testing and automatic linkage of results to the EMR are not yet extensively mentioned in literature. The possible usefulness of CRP POCT beyond the context of adults presenting with RTIs, is suggested by other studies, including the use in out-of-hours care facilities (74). In the pediatric population, CRP POCT is commonly recommended as a decision-support tool, partly because of its minimally invasive nature (75–77).

Guidelines in other countries, such as the United Kingdom, the Netherlands and Norway, already recommend the use of CRP POCT for RTIs, but only when clinical assessment leaves physicians in doubt (42–44,69,78). For broader implementation of CRP POCT, support by laboratories for technical problem solving and quality control support is paramount, as affirmed by literature (62,79). In addition, the financial aspect remains an important issue for integration in national guidelines, since without reimbursement policy, CRP POCT has a low chance of being implemented on a large scale (79). A recent Belgian budget impact analysis on integration of CRP POCT for adults with acute cough, estimated a significant financial burden, especially when GPs' compensations are included (80)The evidence about savings related to reduced antibiotic use and decreased AMR rates is still limited (81). However, some studies show moderate evidence for cost-effectiveness of CRP POCT, especially when combined with communication training for clinicians (49,50).

4.3 Implications for clinical practice

CRP POCT promises a high potential in reducing diagnostic uncertainty alongside clinical judgement and supporting GPs in on-the-spot clinical decision-making in daily general practice. Being less invasive than a standard blood test, CRP POCT is especially useful in the pediatric population, where clinical assessment is considered more difficult. To facilitate smooth integration into existing GP workflows, structured training programs should be rolled out alongside a standardized laboratory support system to assist with error management and to ensure consistent quality control procedures. Simultaneously, the further technological development of CRP POCT devices hopefully leads to even faster and easier CRP measurements and devices that require less blood. To successfully guide therapeutic decisions, clear standardized cut-off values of CRP should be established in national guidelines for every type of infection and patient population, this way aiming to reinforce antibiotic stewardship and consequently reduce antibiotic resistance. A final condition for general implementation is the need for a fair national reimbursement strategy that rules out unnecessary overuse by patients or GPs.

4.4 Implications for future research

Since our study design was limited to the use of CRP POCT in adults with acute cough, more evidence should be gathered regarding the use of CRP POCT in other indications and target groups. An important target group to mention in this context are children. Given the well-documented diagnostic uncertainty mentioned by GPs in assessing acutely ill children, CRP POCT could serve as a highly valuable tool to support clinical decision-making, especially because it is less invasive than a standard blood test. Other areas of application within primary care, such as home visits, nursing homes and out-of-hours service, were not explored in this analysis and could be the subject of future studies. Solo practices and rurally localised practices were also not represented and should be addressed in future research.

Future research regarding the economic aspects of CRP POCT should focus on carrying out a cost-benefit analysis weighing the costs that will be saved by avoiding antibiotic overuse and thus antimicrobial resistance against the costs of systematically rolling out CRP POCT in Belgian primary care. This information can then be used to guide the establishment of national reimbursement modalities, which were considered necessary for broader implementation by the professionals in our study.

Over time, it is important to evaluate whether the use of CRP POCT leads to a meaningful reduction in unnecessary/inappropriate antibiotic prescribing in Belgian primary care which contributes to the global fight against antibiotic resistance.

4.5 Strengths and limitations

The implementation of CRP POCT devices in Belgian general practice was evaluated using a mixed methods study design where the data from the qualitative and the quantitative part of the study generally aligned and confirmed each other increasing the validity and reliability of the results. Both the interview guide and the survey were developed by a team of individuals with different scientific backgrounds, including GPs to ensure relevance for daily clinical practice. The use and implementation of CRP POCT devices was carried out in realistic, functioning Belgian general practices which reinforces the fact that the findings are applicable in everyday clinical practice. During the focus groups, opinions were gathered from various parties including GPs and a GP in training, laboratory staff and firm representatives ensuring that the topics of discussion were examined from different perspectives. The subsequent processing and coding of the focus groups was again carried out by a team of researchers with different professional backgrounds with the aim of reducing potential bias risk. The COREQ-checklist was used as a guidance to provide a high-quality and complete representation of the qualitative data collected in the focus groups.

However, our study also has some limitations. First, our study was carried out in Flanders and Brussels, only rendering a small sample size. The majority of participants were women who worked in group practices localized in urban areas. Solo practices and practices in rural areas are not represented in this study meaning that specific findings/opinions related to these contexts are missing in our study results. Different types of devices were used across all participating practices, which can cause differences in user experience apart from the concept of CRP POCT itself. At the start of the study, no cut-off values were provided for interpreting the measured CRP values resulting in significant individual differences in the interpretation of the measured values. Several participants reported the usage of CRP POCT outside the scope of the study (for example on house visits, in nursing homes or during out-of-hours service), but those involved in these contexts did not participate in the focus groups, resulting in a lack of potentially valuable insights from these professionals.

Our study design is susceptible to various forms of bias. As mentioned above, there is a risk of sampling bias, given the fact that our sample size is small and is limited to mostly female GPs working in group practices in urban areas. Another manifestation of sampling bias lies in the fact that results are based solely on the experiences of GPs and their perceived impact on patients, where GPs could have misinterpreted patients' ideas from their own beliefs and points of view. The study design with focus groups implies that there is a risk of moderator bias whereby the (non-)verbal cues of the moderator can influence how the participants respond during focus group discussions. Participating in the study was voluntary, causing an inherent risk of selection bias. The GPs who applied voluntarily are more likely to have had a high interest in the topic and a positive attitude towards the implementation of CRP POCT before entering the study. The risk of recall bias is high

since GPs might have forgotten about their exact experiences with CRP POCT when the focus group discussions found place. Social desirability bias cannot be ruled out because participants might have influenced each other during the focus group discussions causing them to give socially desirable answers. When discussing in group, there is an inherent risk of conformity bias or group thinking when participants adapt their opinions and views to those of the group. Since the representatives of the different labs and firms involved were present during the focus groups, there is a risk of courtesy bias where participants could have been milder in their criticism about certain devices or services. Finally, interpretation bias should be considered where the professional background and prior existing ideas/perceptions about CRP POCT in general practice of the different researchers can influence the way they have interpreted the qualitative data.

5. Conclusion

This mixed methods study suggests that CRP POCT represents a promising supplementary tool in clinical decision-making for GPs managing adults with acute cough.

According to the participating GPs, CRP POCT could reduce diagnostic uncertainty in daily primary care practice. It provides additional information for clinical decision-making where it is important to note that clinical assessment and professional judgement remain the cornerstone of primary care. Additionally, CRP POCT could enhance both patient-doctor communication and co-consultation among GPs. Its use was also perceived as having the potential to reduce unnecessary antibiotic prescriptions thereby contributing to the fight against AMR.

Future research should explore the broader applicability of CRP POCT in various indications and contexts outside the scope of this study, especially in the pediatric population. Economic efficiency should be evaluated as well as the effects over time on antibiotic prescribing behavior and thus antibiotic resistance in primary care.

For successful and sustainable implementation in Belgium, clear frameworks regarding reimbursement and costs, national guidelines regarding the interpretation of CRP values and adequate support structures, including a standardized policy on quality control measurement, must be developed.

Overall, CRP POCT appears to hold significant promise in routine daily primary care practice, while also contributing to the global fight against AMR.

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7. Additional files

7.1 Ethical approval

Antibioticafalen

Dossiernr.: MP033645
Masterproef: Masterproef I HAIO; 2022-2026
Faculteit/opleiding: Faculteit Geneeskunde - Master in de huisartsgeneeskunde
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Korte omschrijving / abstract: Het ontstaan en de verspreiding van antimicrobiële resistentie (AMR) is een complex fenomeen met meerdere onderling gerelateerde oorzaken en gevolgen. AMR gaat gepaard met een verhoogd risico op therapiefalen en terugkerende infecties. Bijgevolg speelt het een belangrijke rol in de stijgende morbiditeit en mortaliteit en, uiteindelijk, de stijgende kosten van de gezondheidszorg. Hoewel het verband tussen antibioticagebruik en resistentie duidelijk is aangetoond, is dit een complex verband dat waarschijnlijk door een reeks factoren wordt beïnvloed en is er nog veel onbekend over de precieze oorzaken van AMR. Slechts enkele studies hebben het effect van roken, de body mass index of veelvoorkomende chronische aandoeningen op het ontstaan van antimicrobiële resistentie onderzocht. Tot op heden blijven preventiemaatregelen grotendeels algemeen met weinig of geen differentiatie tussen individuen en gezondheidszorgomgevingen. Helaas blijft AMR, ondanks maatregelen die enig succes laten zien, een grote bedreiging voor de moderne gezondheidszorg en is er weinig zicht op verbetering. Een beter begrip van de risicofactoren en oorzaken van AMR zou de ontwikkeling van meer gerichte preventiestrategieën kunnen ondersteunen, maar is er momenteel nog niet.
Klinische praktijkrichtlijnen, gepubliceerd door nationale gezondheidsautoriteiten, kunnen artsen ondersteunen bij de juiste behandeling en hun keuze van antibiotica. Hoewel deze wijdverspreid zijn, schrijven artsen nog steeds erg vaak antibiotica voor wanneer deze niet noodzakelijk zijn. Een applicatie met aanbevelingen voor het voorschrijven van antibiotica en hun motivering, een zogenaamd clinical decision support system (CDSS), kan de begrijpelijkheid en leesbaarheid van klinische praktijkrichtlijnen verbeteren. Dit kan de toepassing van aanbevelingen met betrekking tot antibioticabehandeling verhogen en kan helpen om AMR aan te pakken.
Ondanks grote inspanningen om het ongepast voorschrijven van antibiotica in de eerstelijnszorg in België te voorkomen, zijn de doelstellingen, zoals beschreven in het Nationaal AMR Actieplan, nog niet bereikt. In het afgelopen decennium werden verschillende interventies, zoals point-of-care testing (POCT) ontwikkeld, gelanceerd en geëvalueerd, zowel in België als in andere (Europese) landen. Echter veel van deze interventies, waaronder POCT, zijn niet op grote schaal geïmplementeerd of geëvalueerd in de Belgische context. Klinische studies in de eerstelijnszorg (huisartsenpraktijk) hebben het gebruik van CRP point-of-care testen (POCT) onderzocht om het voorschrijven van antibiotica te sturen, wat resulteerde in een aanzienlijke vermindering van het voorschrijven van antibiotica zonder de patiënt te schaden. Deze interventie bij volwassenen met acute hoest is ook kosteneffectief gebleken, evenals effectief op de langere termijn. In verschillende Europese landen maken POCT-CRP-testen deel uit van de richtlijnen voor goede medische praktijken voor acute hoest of luchtweginfecties in de huisartsenpraktijk, bijvoorbeeld in Nederland. Voordat POCT-CRP nationaal kan worden ingevoerd in België, moeten een aantal organisatorische aspecten worden aangepakt.
Doelstelling 1a: verschillende uitkomstparameters beoordelen, waaronder de toegepaste definities voor antibiotica therapiefalen, de categorisatie van therapiefalen op basis van deze definities en de specifieke ziekte of ziekten waarvoor het mislukken van de antibioticabehandeling werd beoordeeld.
Doelstelling 1b: het kwantificeren van de incidentie van eerstelijns antibioticafalen in de algemene bevolking, evenals de variatie in de tijd, per subgroep van leeftijd en geslacht, evenals per type infectie en antibioticaklasse. Ook willen we onderzoeken of bepaalde demografische, klinische, gedrags- of zorgsysteemgerelateerde factoren geassocieerd zijn met een hogere incidentie van antibioticafalen in de eerste lijn, en hoe deze variëren per type infectie en antibioticaklasse (met behulp van Intego en CPRD database).
Doelstelling 2: meer inzicht krijgen in de percepties van clinici met betrekking tot het ongepast voorschrijven van antibiotica. We willen onderzoeken wat zij beschouwen als risicofactoren voor het ongepast voorschrijven van antibiotica en in hoeverre deze risicofactoren overeenkomen met eerder databaseonderzoek. Daarnaast willen we ook bepalen hoe we hen kunnen ondersteunen bij het voorschrijven van het juiste antibioticum, bijvoorbeeld met clinical decision support systems (CDSS).
Doelstelling 3: het peilen naar ervaringen met de POCT-CRP-apparaten in de huisartsenpraktijk. We zullen een onderzoek organiseren onder relevante stakeholders die betrokken zijn bij dit proefproject en de implementatie van het POCT-CRP-apparaat door middel van een enquête en focusgroepdiscussies. Vanuit de ervaringen van de relevante stakeholders willen we beschrijven hoe de implementatie verliep in termen van organisatie, evaluatie van haalbaarheid, uitvoerbaarheid, barrières en facilitatoren van implementatie.

Toegepaste technieken:	Kwalitatief onderzoek, kwantitatief onderzoek en systematisch literatuuronderzoek.
Trefwoorden:	antibioticafalen antibioticaresistentie
Gewenste taal van communicatie:	nl
Promotor:	Prof Dr Jan Verbakel (u0042064)
Copromotor:	/ Annelien Dankaerts (r0759712)
Organisatie:	KU Leuven
Dienst:	Academisch Centrum voor Huisartsgeneeskunde
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De verstrekte informatie toont aan dat het onderzoek in het kader van de masterproef integraal deel uitmaakt van een studie die reeds werd goedgekeurd door een erkend ethisch comité.

U hoeft bijgevolg geen nieuw dossier in te dienen in het kader van uw masterproef. Indien de studie doorgaat aan de UZ/KU Leuven en nog niet is goedgekeurd door EC Onderzoek van de UZ/KU Leuven, dient de studie echter nog wel bij dit ethisch comité te worden ingediend. Gelieve dan contact op te nemen met EC Onderzoek van de UZ/KU Leuven. Gelieve u bij het betreffende comité te informeren en u te conformeren aan de daar geldende procedures en hun adviezen te volgen en de betrokkenheid van de KU Leuven voor het vervolledigen van de masterproef toegelaten is.

Onder voorbehoud van de volledigheid en correctheid van de door u verstrekte gegevens, krijgt u hierbij de goedkeuring om het onderzoek in het kader van de masterproef te starten.

Wij willen u erop attent maken dat u zelf verantwoordelijk blijft voor uw onderzoek. Bovendien doet elke wijziging aan de door u verstrekte gegevens omtrent de onderzoeksopzet elke eerdere goedkeuring vervallen. U dient in dat geval een amendement te maken aan uw huidig dossier bij het comité dat eerder uw dossier goedkeurde.

7.2 Consolidated criteria for reporting qualitative research (COREQ): 32-item checklist

No. Item	Guide questions/description	Reported on Page #
Domain 1: Research team and reflexivity		
Personal Characteristics		
1. Interviewer/facilitator	Which author/s conducted the interview or focus group?	16
2. Credentials	What were the researcher's credentials? E.g., PhD, MD	16-18
3. Occupation	What was their occupation at the time of the study?	16-18
4. Gender	Was the researcher male or female?	16-17
5. Experience and training	What experience or training did the researcher have?	16-18
Relationship with participants		
6. Relationship established	Was a relationship established prior to study commencement?	18
7. Participant knowledge of the interviewer	What did the participants know about the researcher? E.g., personal goals, reasons for doing the research	16-18
8. Interviewer characteristics	What characteristics were reported about the interviewer/facilitator? E.g.,Bias, assumptions, reasons and interests in the research topic	18
Domain 2: study design		
Theoretical framework		
9. Methodological orientation and Theory	What methodological orientation was stated to underpin the study? E.g., grounded theory, discourse analysis, ethnography, phenomenology, content analysis	16
Participant selection		
10. Sampling	How were participants selected? E.g., purposive, convenience, consecutive, snowball	16
11. Method of approach	How were participants approached? E.g., face-to-face, telephone, mail, email	16
12. Sample size	How many participants were in the study?	16
13. Non-participation	How many people refused to participate or dropped out? Reasons?	16
Setting		
14. Setting of data collection	Where was the data collected? E.g., home, clinic, workplace	16
15. Presence of non-participants	Was anyone else present besides the participants and researchers?	16
16. Description of sample	What are the important characteristics of the sample? E.g., demographic data, date	16
Data collection		
17. Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	16
18. Repeat interviews	Were repeat interviews carried out? If yes, how many?	No
19. Audio/visual recording	Did the research use audio or visual recording to collect the data?	Audio
20. Field notes	Were field notes made during and/or after the interview or focus group?	No
21. Duration	What was the duration of the interviews or focus group?	20

22. Data saturation	Was data saturation discussed?	No
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction?	No
Domain 3: analysis and findings		
Data analysis		
24. Number of data coders	How many data coders coded the data?	5
25. Description of the coding tree	Did authors provide a description of the coding tree?	Yes
26. Derivation of themes	Were themes identified in advance or derived from the data?	Derived from data
27. Software	What software, if applicable, was used to manage the data?	Nvivo
28. Participant checking	Did participants provide feedback on the findings?	Yes, 39
Reporting		
29. Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? E.g., participant number	Yes, 22-36
30. Data and findings consistent	Was there consistency between the data presented and the findings?	Yes
31. Clarity of major themes	Were major themes clearly presented in the findings?	Yes
32. Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	No

NR: not reported; Suppl. M.: Supplementary Material

Developed from: Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. International Journal for Quality in Health Care. 2007. Volume 19, Number 6: pp. 349 – 357

7.3 Interview guide (focus groups)

- How did you experience the implementation of the POCT CRP device in your practice?
- What are the advantages of having a POCT CRP available for a patient with acute cough?
- What are the disadvantages of having a POCT CRP available for a patient with acute cough?
- How was the implementation of the POCT CRP device organized in your practice?
    - How did the installation of the device go?
    - Did you encounter any technical difficulties while using the device? If yes, which ones? How did you address them?
    - How did the integration of the device with the electronic medical record go?
    - Who was the point of contact in your practice for problems or questions regarding the POCT CRP device?
- How does the use of the POCT CRP device fit into your workflow?
    - For which patients did you use the POCT CRP device, and for which you did not?
    - What made you decide to use the device?
    - What made you decide not to use the device?
    - At what point during the consultation did you decide to use the POCT CRP device?
    - Did you use the POCT CRP device during the consultation, or did you ask patients to come back for sampling?
    - Did you feel that the use of the POCT CRP disrupted your personal workflow? If yes, in what way?
- Feasibility
    - Did you encounter any issues while using the POCT CRP device that prevented you from using it? If yes, which ones?
    - Did you notice any aspects that make it impossible to implement the POCT CRP device in your daily practice? If yes, which ones?
    - Were you able to use the POCT CRP device during every consultation where it was desired? If not, what were the reasons?
- Are there any topics that were not discussed during this focus group session that you feel should have been addressed?
- Of all the characteristics of the clinical decision support we discussed, which one is the most important to you? (Question for each participant)

7.4 Quotes in original language (Dutch or French)

7.4.1 Theme 1: CRP POCT is an objective tool that reduces diagnostic uncertainty

F2P10: Et nous, notre métier est completement basé sur les probabilités, sur l'expérience, sur l'anamnèse, la clinique. Et y à rien à faire, les machines comme ça, ça doit devenir incontournable.

F3P2: Als't duidelijk geruststellend is, ga je het nooit gebruiken, als't duidelijk nie oké is, ga je het ook niet gebruiken, uhm, tis een beetje in die grijze zone inderdaad he.

F1P1: Start ik, alle doe ik toch nog de test om ja, mijn differentieel landschap, of mijn diagnostisch landschap toch nog te verkleinen.

F1P8: Ik vind ook wel dat het een voorwaarde heeft da je veel minder uitgesteld antibiotica voorschriften meegeeft nu. Ik dee dat ook ni zo veel omdat ik daar ni vree in geloof. Maar inderdaad, als ge dan de vrijdag iemand hebt. En ge hebt een CRP da echt laag is en het is nu ni da da iemand doodziek is eh, dan dan vind ik da je minder snel een uitgesteld voorschrift gaat meegeven ook dan als ge geen waarde hebt, als ge't volledig in het gewisse moet doen.

F3P1: Als ge twijfelt viraal of bacterieel, als ge echt twijfelt over, alle ja met klinisch onderzoek. Of is het hier een surinfectie, of is't toch een virale infectie he.

F3P9: Ik vond het ook als dan beginnende huisarts soms een beetje een toetsing voor mijn eigen klinisch onderzoek, als ik dan zo crepitaties ofzo hoorde dat ik dacht aaaah hè, dan zou ik zonder CRP toestel misschien dan antibiotica toch eerder gestart zijn en dan vond ik het soms wel interessant van dan zo efkes zo objectief euhm nog nen extra parameter erbij te halen ja.

F1P8: Dat is misschien ook om om, als ik dan vergelijk met de HAIO. Zij heeft natuurlijk ze, ze is één oktober gestart als HAIO, dus ze is eigenlijk gestart met de aanwezigheid van een CRP toestel en ik heb al 20 jaar zonder CRP toestel gewerkt. Dus ik merk wel dat zij daar dan ja direct veel meer zou op voortgaan.

F3P2: Voordelen, veel voordelen (iedereen lacht), (onverstaanbaar) beleid. Op zich ja, tis wel handig he of zo bij mensen die fan zijn van antibiotica (lacht) toch wel kunnen, allee gemakkelijker kunnen overtuigen, of zo iets objectiefs hebben.

F3P8: En bij mij wast ook een beetje diagnostische onzekerheid binnen dat specifiek geval dan. Die patiënt wou eigenlijk niet naar spoed en ik had eigenlijk niet zo'n goed gevoel en dat geeft mij dan nog extra gevoel van ah ja oké ik ben toch juist, ja (velen bevestigen met 'ja' of uhum).

F2P12: On l'a aussi utilisée en suivis de toux, parce que … voilà la toux aigues et puis aussi la toux qu'on a pu voir deux trois fois avec une CRP qui évoluait et je trouve que ça aussi c'est intéressan. Ce qu'on a trouvé très intéressant c'est d'avoir le résultat immédiatement.

F1P6: Bij kindjes inderdaad ook wel, want ja, een bloedafname bij een kind, dat deed ik inderdaad zelf bijna nooit. Dus in in da opzicht is da wel elegant. Allé, het is ook ni aangenaam, maar het is toch niet te vergelijken met een echte bloedafname. Dees lukt, allé quasi altijd ook. Bij een bloedafname bij bij een kind kunt ge al tegenkomen als het dan niet goed lukt of het is het ligt niet stil en en het ga heel moeilijk. Dat dat dan trauma's worden, dus daarvoor vind ik het ook echt wel een meerwaarde.

F3P2: Alle, want ik denk dat er ook gewoon echt vaak antibiotica wordt gegeven bij kinderen gewoon omwille van die diagnostische onzekerheid en ge wilt toch niet bij een kind iets missen ofzo alle, ja.

F3P7: Awel ja, tis da, tis da. En bij kinderen kan het ook wel 2 richtingen uitgaan denk ik uhm een een superziek kind met zo gelijk ne CRP die negatief is of een kind waarda je denkt, tis wel nog cava en dan plots zo ne superhoge CRP omdat klinisch heel vaak moeilijker is bij een kind (meerderen bevestigen). Alle vo voor mij denk ik dat daar de grootste meerwaarde ligt uhm.

F1P8: k zie ook dat het op meer en meer spoed gebruikt wordt. Ik weet dat bij ons in de wachtpost staat ook een toestel, waar dat toch ook geregeld, ik zeg niet door iedereen. Maar waar dat toch geregeld gebruik van gemaakt wordt en ik denk dat dat... Eigenlijk zou dat een onmisbaar onderdeel van ons (aarzelt) ons materiaal zou moeten beginnen worden. Wij hebben ook allemaal ne glycemie prikker in huis ook, hè.

7.4.2 Theme 2: Easy to use CRP POCT with reliable support integrates well in existing workflow

F3P1: Ja, super, alle gebruiksvriendelijk (meerdere mensen bevestigen met 'ja').

F4P2: Ik wou ik wou die sneltesten al hebben en als da toestel daar dan kwam dan was ik helemaal blij (lacht). Euhm dus ik ik kan wel nimeer zonder omdat da ergens een beetje geruststelling is als ge ergens vastzit da ge iets kunt doen.

F1P1: ...wij continu, ja het CRP toestel bij ons gehad en ik vond het een enorm pluspunt om te hebben. Ik ga het missen als het er niet meer is.

F2P12: Ce qu'on a trouvé très intéressant c’est d'avoir le résultat immédiatement. On parlait du vendredi soir, mais même le lundi soir, on fait le prélèvement à 17 h, on l'envoie au laboratoire, certains labos sont éventuellement sur la balle, nous préviennent à 21 heures, puis il faut recontacter le patient. C'est compliqué, alors que là, on a directement l'information ça nous permet aussi de d'envisager le suivi du patient de manière totalement différente. Donc je trouve que ça a vraiment beaucoup d'intérêt.

F4P1: Ik denk (wordt onderbroken) Ik denk uhm, ge kunt de, het enigste waar da ge geen invloed op hebt natuurlijk is. Is de doorlooptijd van uw, van uw toestel he, ge kunt heel snel zijn in in afname en daar beter in worden. Ma natuurlijk nooit da toestel trainen dat het sneller zijnen test doorloopt dan dan dat het tijd nodig heeft. Ik vind da wel ne belangrijke een belangrijke factor.

F1P1: Dus en de patiënt ervaart dat ook als zeer positief dat dat ook onmiddellijk gekend is. Da ze niet moeten wachten tot den dag nadien voor hun resultaat of allé ja.

F2P2: Moi je trouve quand même que même si ces tests sont extrêmement rapide, interrompre une consultation, faire un prélèvement et d'attendre un résultat, même si c'est pas très long, c'est quand même dans.... dans une consultation où il y a du monde, c'est quand même un temps qui est perdu entre guillemets.

F4P2: La Roche was het he. Ik vond da het moeilijkst. Ik was daar zelf gewoon constant mee aant klungelen. En da ga mij ook wel vree tegenhouden om het dan te gaan gebruiken. Euhm, terwijl als ge gewoon een klein druppelke moe opvangen, das wa properder. En ma ja het kan ook aan mij liggen he, ma ik vond da ni zo heel gemakkelijk.

F1P1: Allé, ik vind vooral bij kindjes inderdaad hebt ge misschien minder bloed, hè. We hebben, nu was het vooral gericht op volwassenen, dus ja, dan moogde wel ne keer duwen op die vinger, moogde wel nog ne keer duwen. Bij een klein kindje is da misschien minder interessant.

F1P8: Met heel weinig onderscheid tussen de twee, oké. Den ene heeft minder bloed nodig, den tweede vraagt ietskes meer handelingen misschien, maar ge kunt het dan à la limiet zelfs langer bewaren en meepakken op de baan... Ik denk dat dat ook een voordeel is. Dus ja, één van die twee denk ik dat zeker zeker welkom is. De anderen zouden ook welkom zijn. Maar praktisch vind ik het andere gewoon, de andere twee handiger.

F3P7: Het nadeel is dan wel bij jullie, ge kunt da zeker niet superlang laten staan of het stolt he. Meestal analyseer je toch direct, maar ge kunt bijvoorbeeld... Terwijl bij de 10 microliter ofzo ja dan hebt je al ietske meer speling.

F3P3: Ik denk da ruimte dervoor hebben ne belangrijke is. De gemeenschappelijke ruimte, da iedereen deraan kan, zonder iemand te storen, als ge het echt wilt, ja.

F1P9: Bij ons staat het CRP toestel ook in één van de kabinetten wat misschien ook ervoor zorgde dat we het minder hebben gebruikt, omdat je er ook minder, ja allee ge wilt die andere niet storen, of allee dus het zat ook wat minder in onze vingers, hoe moet ik het zeggen.

F1P1: Bij ons ook. Wij hebben geen verpleegkundige, dus wij konden de patiënt sowieso niet doorsturen naar de verpleegkundigen, dus we deden het sowieso zelf. Maar inderdaad ge deed uw allé, en uw testen ondertussen... Vroegde moest ik al iets anders voorschrijven van antibiotica, allé antibiotica, moest ik iets anders voorschrijven van medicatie. Er zijn wel nog andere dingen of hun attestjes voor het werk dat ge aan het maken zijt. En tegen dan is den test gekend.

F1P8: Ik deed dat meestal zelf tijdens het consult en uiteindelijk de meeste testjes - allé wat is dat - twee of drie minuten heb je het resultaat, dus ik vind dat zeker niet de moeite om te zeggen van zet die in de wachtzaal tot als resultaat gekend is of de verpleegkundige het te laten doen. Ik vind dat dat

heel snel iets is dat je tussendoor kan doen. Dat eigenlijk... Ik denk dat je langer discussieert met de patiënt waarom dat ze geen antibiotica of wel antibiotica nodig hebben dan dat het resultaat van den test duurt.

F4P2: Bij mij wel altijd na het klinisch onderzoek, da ik altijd wel eerst de kliniek gedaan en dan als ik daar in twijfelde, dan inderdaad ne CRP of als ik eerder niet twijfelde, maar het gevoel had van de patiënt is nog niet volledig mee en da zou extra helpen dan euhm ma ik heb wel altijd eerst klinisch onderzoek gedaan.

F4P1: ...soms ook echt op een later, op een later moment. Uhm, da zorgde er dan natuurlijk voor dat de consultatie soms wel een beetje uitliep omdat ge natuurlijk nog heel de uh, hoe vroeger dat je het doet natuurlijk, hoe meer dat natuurlijk in uw consultatie kan, kan passen he (SG bevestigt met uhum) euhm dus da was, da was heel wisselend.

F1P5: Ja, ik vind het ook niet allee het was leuk dat het erin komt, maar dat hoeft inderdaad niet per se, omdat we het inderdaad noteren en dan kan je het uit uw pakket wel uithalen alle. Als je het zo codeert dan kan je het er wel uithalen. Dus op zich allee niet dat ik het werk niet nuttig vind, maar gewoon het allee het is, ik vind het ook niet erg. Ik had het niet gemist, mocht het er niet geweest zijn.

F3P7: Mor finaal ist wel handiger denk ik. Alle als ge kunt kiezen... (wordt onderbroken) da het wel bij je andere laboresultaten staat en da je het ziet in het geheel van... (wordt onderbroken) parameters.

F1P1: Bij ons was die koppeling er, dat ging eigenlijk heel vlot. De dag nadien zat dat eigenlijk gewoon in ons medisch pakket, zoals ge eigenlijk ja, bloed trekt en dat dan toekomt. Wij hebben nooit problemen gehad met geen enkel toestel, eigenlijk ook alleen in begin ne keer één of twee foutmeldingen. Maar dat was het dus ja wij hebben daar niks van negatieve ervaringen mee.

F4P1: Hmm, ma ja bon das nu buiten euh. Nee ma eigenlijk ik denk da wij ni echt obstakels hebben ervaren of of dingen in het gebruik van het toestel. Nee, nee absoluut ni.

F3P9: Ik gaf dat dan meestal door aan onze secretaresse en dan stuurde zij wel een mailtje. Uhm, ik denk dat dat dan naar, naar de klinisch bioloog was eh, dat dat dan gestuurd werd en we kregen daar altijd vlot antwoord op met goede instructies uhm. Ik denk ook, we hadden op een bepaald moment een probleem met ons toestel, omdat het ze onder den blazer stond van de verwarming dat gelijk wat oververhit was geraakt en hebben we ook onmiddellijk een ander gekregen dus uhm ja.

F2P10: Les firmes sont très réactives, il faut être honnête. C’est impressionnant. Ils ont des moyens, ils ont du personnel qui est fort réactif. Franchement, moi, j'utilise encore un appareil. Quand j'ai un souci, j'envoie un mail. J'ai une réponse très rapidement. "On arrive" ou franchement c’est…

F3P7: Ook bijvoorbeeld QC producten zijn echt ni goedkoop, alle ge betaalt misschien 150 euro voor 1 doosje, waar da je uiteindelijk bij wijze van spreke niks terug uithaalt. Kdenk da da ook wel nog nen belangrijke is, alle een praktisch puntje in de implementatie.

7.4.3 Theme 3: CRP POCT supports decisions and strengthens patient communication, fostering antibiotic stewardship

F4P1: “en anderzijds soms bij randgevallen waarbij dat ik klinisch euh een beetje vreesde voor een, voor een ernstige infectie om daar dan al dan niet een uitsluiting of een bevestiging van mijn euhm, van mijn klinisch aanvoelen of van mijn klinische inschatting euhm te hebben.”

F2P5: “Et au niveau clinique, ben .. en fait ça,… je pense que ça nous apporte quelque chose de très objectif qu'en médecine générale, c'est vrai qu'on est très fort sur le Gut feeling et l'examen clinique, … et de vraiment aussi ressentir un petit peu comment les gens se sentent, et ça permet une certaine objectivation des choses, en fonction de la CRP.”

F4P2: “Euhm, dus ja, maar ook omgekeerd zoals mijn collega zei, uhm stelt het u ook ergens een beetje gerust van uhm der is helemaal geen infectie en tis oke...”

F1P8: “het is inderdaad je verschiet soms in de twee kanten dat je denkt van oké, dit zal wel meevallen maar we zullen toch een keer controleren, want het duurt bijvoorbeeld al iets langer en dat je dan een torenhoog CRP hebt. Maar ook omgekeerd dat je iemand bij U hebt dat je zegt van, die zit er nu echt wel doodziek uit en dat dat allemaal zeer goed meevalt en dacht van oké”

F1P8: “En soms verrast, verschiet ge ne keer. Ik heb ik heb het gehad dat ik dacht van oke, dit valt mee en dan heb je een CRP van 150. Dan dan kan je toch eigenlijk vrij snel schakelen, terwijl dat je da inderdaad. Anders zie je die mensen twee dagen later terug of moet je ze laten opnemen. Dus ik denk dat dat een grote voorwaarde is.”

F2P10: “En tout cas, grâce à la machine, il y a eu deux ou trois cas où j'ai pas raté quelque chose.”

F2P10: “Et je pense que ça amène plus de test de labo, que moins de test de labo.
Cadre scientifique-LABO: Pourquoi ? *MG 2:* ça amène plus de test ? *MG 4:* Parce que ça va t'amener parfois à avoir un diagnostic qui va peut-être t'amener à faire des globules blancs en plus ou des petits test en plus ou dire tiens...

F3P2: “Das ook wel, ja das ook gewoon een kwestie van gewoon uitleggen aan uw patiënt he van het is zo hoog, dus k'wil toch nog verdere info, of ja tis toch lager dan da k'denk en dan weet ik nog ni goe wa dat het is. Dus kzou toch nog verder willen kijken, alle ik denk: mensen nemen het ons nooit kwalijk, denk ik, als we zeggen da we verdere informatie wensen.”

F2P5: “Et moi, par exemple, parfois, je faisais des prises de sang et je prenais dans le tube vert. Je faisais directement le test, et ça, c'était aussi, je trouve, très intéressant, parce que j'avais directement

ma CRP, tout en envoyant le reste au laboratoire pour avoir tout le reste. Et en fait ça, j'ai trouvé ça aussi super utile."

F1P1: "Misschien toch nog één nadeeltje maar het is gewoon, denk ik, heel casusspecifiek geweest. Wij hebben een patiënte gehad die heel, heel ziek leek, achteraf gebleken waarschijnlijk ook wel heel ziek was. Maar het CRP heeft ons eigenlijk toen valselijk gerustgesteld. Wij hebben toen een CRP gemeten van minder dan drie, maar spijtig genoeg is ze twee dagen later met een septische shock opgenomen met een pneumonie op nen influenza dus alle ja, dat was ergens dan zo, voor ons wel. Maar misschien allee ik denk zonder dat CRP had, het was gewoon voor ons wat meer een bevestiging van oh nee het is echt wel oké, terwijl dat dan misschien valselijk ja dat gevoel had."

F1P8: "maar dat ja ne CRP toch wel achter komt dat iemand die fel ziek is toch nog relatief laag kan zijn en en dat je dan toch echt goed moet afspreken met die patiënt van ja, ja volgt dat de volgende uren toch wel goed op als je echt zieker wordt, dan dan moet je toch terug contact opnemen he"

F3P2: "Da is soms wel (hapert), alle, dat de kliniek nog (lacht) belangrijk is natuurlijk en de follow-up, want ge kunt zo in een vroeg stadium dan nog een normaal CRP hebben, en dat dan toch doorstijgt. We mogen ons er ook niet blind op staren ofzo, denk vooral dat een beetje (mensen bevestigen mompelend)."

F4P2: "Het moment da ge een CRP ook gaat bepalen, het moment van de ziekte. En als ge het te vroeg doet zijde eigenlijk nog altijd ni zeker of da het dan oke is. Dus ik vind da eigenlijk vooral voor een lange aanslepende hoest wel euh een nuttig iets, uhm maar zo nog een prille hoest of net koorts daar zijde eigenlijk ni superveel mee."

F3P7: "Ja. Maar ja, kweet eigenlijk ni officiëel wat dat de cutt-offs waren die eigenlijk moesten gehanteerd worden."

F4P2: "Ma als tzo niets is ist goe, en als theel veel is ist ook goe. Ma iets tussen de 2, dat is ambetant."

F3P2: "Ja, ja, maar toch heb ik het gevoel dat dat nu een hulpmiddel ergens kan zijn om, ze hebben dan zo iets, ze hebben graag soms iets objectiefs in handen ofzo en dan helpt het wel gelijk, maar los ervan, ja dat het inderdaad niet niet de bedoeling is dat we het alleen daarvoor (onverstaanbaar)."

F2P12: "Ben c'est-à-dire que ma consœur faisait un test, elle avait un test qui était douteux entre … elle avait 27 et trouvait quand même que le patient n'était pas très bien donc « est-ce que tu peux venir écouter ? », « me donner ton avis? » Et ça, j'ai trouvé que c'était très intéressant."

F1P1: "Dus en de patiënt ervaart dat ook als zeer positief dat dat ook onmiddellijk gekend is. Da ze niet moeten wachten tot den dag nadien voor hun resultaat of allé ja."

F2P3: "Est-ce que je peux prendre l'avis pateint ? Non, mais c'est super intéressant de vous entendre. Parce que moi je suis côté plutôt patient, et je trouve ça super rassurant, parce qu'on sait qu'un médecin n'a pas le savoir absolu et qui ne peut pas être toujours sur, même pas dans tous les cas en

tout cas. Et donc quand on est côté patient et qu'il y a l'avis du médecin qui est corroboré par une petite CRP, à côté, c'est extrêmement rassurant sur le fait que oui, on ne va pas prendre des antibiotiques pour rien. C'est … moi je,… côté patient, je trouve ça vraiment très intéressant."

F4P2: "en dat helpt de mensen ook wel om dan uhm me een gerust hart ofzo naar huis te gaan en ook het gevoel te hebben van uhm de arts heeft juist gehandeld en geen twijfel meer te hebben."

F4P1: "Door ziekenhuisopnames te vermijden, of door euhm vroeger in actie te komen in bepaalde gevallen. Of omgekeerd door door euh antibiotica resistentie of antibioticavoorschriften te vermijden door die ni, ni voor te schrijven."

F1P8: "Ik vind ook wel dat het een voorwaarde heeft da je veel minder uitgesteld antibiotica voorschriften meegeeft nu. Ik dee dat ook ni zo veel omdat ik daar ni vree in geloof. Maar inderdaad, als ge dan de vrijdag iemand hebt. En ge hebt een CRP da echt laag is en het is nu ni da da iemand doodziek is eh, dan dan vind ik da je minder snel een uitgesteld voorschrift gaat meegeven ook dan als ge geen waarde hebt..."

F4P2: "Zo vooral het idee van euhm, die persoon hoest en die hoest klinkt niet zo oke, maar we horen niet zoveel klinisch, euhm da was zowat een aanvulling om te weten is er hier, is da hier nu nog een postviraal of is da hier echt nog iets atypisch dat erachter kan zitten. Dus dat heeft mij wel een beetje geholpen in het kiezen of ik al dan niet antibiotica opstart. Uhm, da heeft mij wel vooral minder antibiotica doen voorschrijven, da gevoel heb ik wel gehad."

F1P3: "Als ik zelf he voor mijn diagnostische twijfel enerzijds en soms ook om de patiënt te kunnen overtuigen van de niet noodzaak van antibioticum dan (lacht)."

F3P9: "en ik vond het ook als dan beginnende huisarts soms een beetje een toetsing voor mijn eigen klinisch onderzoek, als ik dan zo crepitaties ofzo hoorde dat ik dacht aaaah hè, dan zou ik zonder CRP toestel misschien dan antibiotica toch eerder gestart zijn en dan vond ik het soms wel interessant van dan zo efkes zo objectief euhm nog nen extra parameter erbij te halen ja."

F1P8: "Zeker als we ons doel-, doelstellingen voor antibiotica een beetje willen halen en die voorschriften naar beneden krijgen. Ja, dat is toch een manier om dat op een, op een gerustere manier te doen, waarbij zowel de patiënt als gij zelf u toch meer gerust zijt om te zeggen van: kijk, we gaan het niet doen. En ook omgekeerd."

F1P1: "ook naar uw patiënt toe, als ge op voorhand al heel duidelijk uitlegt kijk, als het laag is, is het viraal als het hoog, is het bacterieel en je komt dan terug en ge zegt: kijk, het is laag, dan hebben ze daar precies meer vertrouwen in."

F4P2: "en dat helpt de mensen ook wel om dan uhm me een gerust hart ofzo naar huis te gaan en ook het gevoel te hebben van uhm de arts heeft juist gehandeld en geen twijfel meer te hebben."

F2P10: “Et quand vous avez quinze patients et au seizième, vous devez encore vous battre, pour lui dire: pas d'antibiotiques à un moment donné moi honnêtement j'avoue y a des fois où je ne me bats pas. Alors cette machine va m'aider à ne pas me battre et va se battre à ma place quoi. Elle va dire « c'est en dessous de 5 on ne discute pas » et les gens sont comme vous dites, convaincu directement.”

F3P8: “En bij mij wast ook een beetje diagnostische onzekerheid binnen dat specifiek geval dan. Die patiënt wou eigenlijk niet naar spoed en ik had eigenlijk niet zo'n goed gevoel en dat geeft mij dan nog extra gevoel van ah ja oké ik ben toch juist, ja (velen bevestigen met 'ja' of uhum).”

F3P8: “En dan heb ik hem toch kunnen overtuigen (lacht) om naar spoed te gaan, ja.”

7.4.4 Theme 4: GPs expressed concerns regarding costs and reimbursement of CRP POCT

F3P2: “Ik vind zo het aankoop van het toestel dat zou ik kunnen zien als een investering voor da je vindt van oke ja ik vind dit de moeite waard om het te implementeren, da vind ik ni per se dat da moet doorgerekend worden aan de patiënt. Ma als elke cassette dan nog ne keer 5 euro is, ja, dan zitte wel al direct aan... een serieuze inverstering. En da ik dan ook denk van ja is da eigenlijk voor voor ons om per se om te dragen?

F4P1: “Goh ik denk dat het wel, handig zou zijn mocht het mocht er mocht er een terugbetalingssysteem voor zijn he. Dat het voor iedereen een beetje duidelijk is hoe dat hoe dat het gebruikt moe worden he. Ma lopen er denk ik een beetje veel zaken door elkaar. Euhm. Allez als ik ook zo hoor van bij collega’s die dan een CRP toestel hebben op welke manier da da dan gebeurd of of euh. Of al dan niet verrekend wordt, gebeurt er denk ik echt een beetje vanalles. Das wel zo wa Wilde Westen op da vlak. Dus het zou mij wel beter lijken moest er daar een duidelijk kader voor zijn he ja.”

F1P5: “Maar ja, dan vind ik het wel moeilijk als er echt iemand staat op antibiotica en gij laat ze dan betalen voor nen test waarop da ge dan zegt: ziet ge het wel, ik had echt gelijk. Ja, da vind ik ne moeilijke.”

F2P10: “Ici, les patients ne devaient pas payer donc c'était encore plus confortable pour les patients, mais juste pour dire que ça ne dérange pas les patients de payer quand ils voient ce qu'ils ont, comme heu … ils ont…. Les gens n’ont pas de souci à payer un acte technique alors qu’un acte intellectuel ils ont plus difficiles à le payer. Et donc ici ils voient devant eux la machine qui tourne et donc hop il n’y a pas de soucis et donc c'est pour dire qu'il n’y a pas de soucis à le facturer aux patients pour ceux qui veulent utiliser la machine après.”

F3P7: “Aan de andere kant denk ik dat ouders wel rap eventueel nog iets willen betalen voor onmiddellijke resultaat te hebben (meerderen bevestigen), allee bij een kind gaan ze da misschien, alle voor men eigen kind zou ik het ook direct betalen, terwijl voor mezelf zou ik zo misschien eerder iets zeggen van: laat het maar naar t’labo gaan, dat onder terugbetaling valt en da je dan efkes een paar uur wacht ofzo op een resultaat, maar voor uw kind dat immens ziek is, ja als dat dan

bijvoorbeeld vijftien euro ofzo kost, gaan wel veel ouders dat willen betalen denk ik (velen bevestigen)."

F3P7: "Acute hoest bij volwassenen, ja oke, is ook niet het meest urgent he, ge kunt daar eigenlijk wel 3 4 uur wachten op ne CRP van't het labo denk da bij uw kind, da je anders niet rap prikt, kun je eigenlijk heel rap resultaat hebben. Of zo van die zaken moe je urgent naar een ziekenhuis of niet, maar zo acute hoest bij ne volwassene, alle ja ge kunt uitgesteld voorschrijven enal. Ik vind dat eigenlijk ja, wat minder goeie indicatie voor CRP POCT (meerderen bevestigen), maar ja gelijk daar kant er niemand hier iets aan doen he, maar ik vind het minder logisch eigenlijk uhm."

F4P1: "Ja want ik denk dat het op zich zeker geen euhm, allez, het het is geen euhm. Het is geen financiëel zware last denk ik voor de euh voor de gezondheidszorg. En ik denk dat er zeker wel. Ik denk da we der zeker evenveel zorg mee uitgespaard zullen hebben dan da we dermee, allez of dat het zou gekost hebben binnen een terugbetaald kader, kzal het zo zeggen."

F2P12: "Je pense qu'il ne faut pas qu'il y ait un avantage financier à faire un test, parce qu'avoir un avantage financier à faire un test, c'est générer des tests inutiles."

F2P12: "Je trouve que parfois, ça ne me dérange pas de prendre à ma charge un test que je veux faire pour me rassurer pour bien prendre en charge un patient mais je pense que,quand on rend tout gratuit, on pousse la consommation même du patient."

7.5 Full coding tree

7.5.1 Theme 1: CRP POCT is an objective tool that reduces diagnostic uncertainty

CRP test as an extra tool with clinical assessment
Importance of clinical assessment or judgement

Decision to not perform a CRP test
Decision to perform a CRP test
Young versus older physicians
Diagnostic doubt/uncertainty management
Objectification

Indications
- Usage in nursing homes
- Usage in out of hours service
- Usage with children
  - Minimally invasive method
- Use during home visits
- Use of the device for people with acute cough
- Use of the device outside the study
- Follow-up of the patient

7.5.2 Theme 2: easy to use CRP POCT with reliable support integrates well in existing workflow

Ease of use
- Amount of blood needed
- Benefits of the device
- Device adaptation
- Device satisfaction
- Speed of the CRP device: quick or fast
- Storage time of the sample
- Disruption or prolongation of the consultation
- Duration of CRP test
- Duration of the entire testing process
- Type of device
- Disadvantage of the CRP device
- Frequency of use

Workflow or integration in consultation
- Installation/implementation of the CRP device
- Location of the CRP device
- Moment of performing the CRP test
- Multitasking
- Paper work or administration
- Person who performed the CRP test
- Electronic medical record
- Call with results
- Connection lab-EMR
- Notation method of the result of the test in EMR

Link with health network in second line

Technical problems
Time needed to resolve technical issues
Support by the companies
Support by the labs
Quality control

Other
More accessible than a CRP test with the pediatrician
Multiparametric cassettes
Non-electronic CRP test strips

7.5.3 Theme 3: CRP POCT supports decisions and strengthens patient communication, fostering antibiotic stewardship

Added value for patients
Confirmation of gut feeling or intuition
Surprising or unexpected results of the CRP test
Reassurance
False reassurance
General blood test
Co-consultation
Follow-up of the patient
Reliability of the CRP results
More lab tests due to CRP tests
Avoid CRP dependance

Starting or withholding antibiotics
Young vs older physicians

Tool to communicate with patient
Patients wanting repetitive CRP tests
Patient perception of illness
Interpretation of CRP value
(Lack of) evidence or guidelines

7.5.4 Theme 4: GPs expressed concerns regarding costs and reimbursement of CRP POCT

Financial aspect

7.6 Survey questionnaire

1. Which device did you work with in the past month(s)?
2. What is your age (in years)?
3. How many years of experience do you have as a general practitioner?
4. What is your gender?
5. What type of practice do you work in? (solo/duo/group practice)
6. What type of practice do you work in? (monodisciplinary/multidisciplinary)
7. How much time did you need for the training on performing the POC CRP test? (in minutes)
8. How much time did you need on average per test to perform the POC CRP test? (in minutes)
9. How much time did you need on average per control test for performing the quality assurance samples? (in minutes)

Please indicate to what extent you agree with the following statements:
10. The CRP rapid test will deliver reliable and accurate results.
11. The CRP rapid test can be safely used as a tool in treatment decision-making.
12. The CRP rapid test can be easily integrated into my existing workflows.
13. The CRP rapid test can be performed without extending the consultation duration.
14. I am confident that I can perform the CRP rapid test during consultations.
15. I am confident that I can interpret the results of the CRP rapid test.
16. The CRP rapid test can distinguish between viral and bacterial infections.
17. The CRP rapid test will support me in making treatment decisions when I am uncertain about a diagnosis.
18. Performing the CRP rapid test will increase patient satisfaction.
19. I am confident that I can explain the CRP test results to my patients.
20. I will be able to convince patients more easily whether or not they need antibiotics based on the CRP test result.
21. The CRP rapid test will reduce future consultations for similar complaints (e.g., cough).
22. I will make policy decisions based on the results of the CRP rapid test.
23. I will not prescribe antibiotics if the CRP test result indicates that antibiotics are unlikely to be effective.
24. I will prescribe antibiotics if the CRP test result indicates they are likely to be beneficial.
25. I would like to use the CRP rapid test in the future (after this study).
26. The connection to the central laboratory, along with their support and training, is an added value for general practice.

7.7 Participant checking

Dutch form:

Feedback POCT-CRP studie

* Verplichte vraag

1. E-mailadres *

2. In welke mate bent u het eens met volgende stelling: *

Thema 1: CRP POCT helpt diagnostische onzekerheid aan te pakken: CRP POCT fungeert als een objectief hulpmiddel dat diagnostische beslissingen ondersteunt en het buikgevoel en klinisch onderzoek aanvult. Het is vooral waardevol bij diagnostische onzekerheid en helpt virale en bacteriële infecties van elkaar te onderscheiden. Artsen benadrukten het nut ervan bij verschillende klinische indicaties en contexten, vooral bij kinderen, omdat het een minder invasieve methode biedt om de ernst van een infectie te beoordelen.

Markeer slechts één ovaal.

- Sterk mee oneens
- Mee oneens
- Eerder mee oneens
- Eerder mee eens
- Mee eens
- Sterk mee eens

3. In welke mate bent u het eens met volgende stelling: *

Thema 2: Naadloze integratie in de workflow, zorg voor kwaliteit en ondersteuning & gebruiksgemak wordt als zeer belangrijk beschouwd: De test was over het algemeen goed geïntegreerd in de workflow van huisartsen, waarbij artsen manieren vonden om te multitasken tijdens de korte wachttijd. Huisartsen benadrukten het belang van een grondige kwaliteitscontrole en consistente ondersteuning door laboratoria en fabrikanten van apparaten, om installatie- en technische uitdagingen tijdens grootschalige implementatie van CRP-apparaten aan te pakken. De snelheid van het apparaat, de eenvoud en het minimale bloedmonster dat nodig is, werden genoemd als de belangrijkste kenmerken.

Markeer slechts één ovaal.

- Sterk mee oneens
- Mee oneens
- Eerder mee oneens
- Eerder mee eens
- Mee eens
- Sterk mee eens

4. In welke mate bent u het eens met volgende stelling: *

Thema 3: Een hulpmiddel binnen handbereik om beslissingen te nemen en om zo de communicatie met patiënten te verbeteren: Hoewel CRP POCT hielp bij het bevestigen of herbeoordelen van diagnoses, benadrukten artsen dat het het klinisch oordeel moet versterken eerder dan vervangen. Artsen gaven aan dat CRP POCT kan hebben bijgedragen aan een vermindering van het onnodig voorschrijven van antibiotica, doordat het hen verstrekt met meer vertrouwen in het onthouden van antibiotica. Bovendien verbetert het de communicatie met patiënten, waardoor het gemakkelijker is om het onthouden van antibiotica te rechtvaardigen terwijl patiënten gerustgesteld worden.

Markeer slechts één ovaal.

- ◯ Sterk mee oneens
- ◯ Mee oneens
- ◯ Eerder mee oneens
- ◯ Eerder mee eens
- ◯ Mee eens
- ◯ Sterk mee eens

5. In welke mate bent u het eens met volgende stelling: *

Thema 4: Kosten & vergoedingen: een cruciale factor voor brede toepassing en gebruik: Het gebrek aan een gestructureerd terugbetalingsmodel werd geïdentificeerd als een belangrijke barrière voor een bredere implementatie. Hoewel sommige huisartsen zich bereid toonden om in het apparaat te investeren, bleven de kosten van de testpatronen een punt van zorg.

Markeer slechts één ovaal.

- ◯ Sterk mee oneens
- ◯ Mee oneens
- ◯ Eerder mee oneens
- ◯ Eerder mee eens
- ◯ Mee eens
- ◯ Sterk mee eens

6. Eventuele bijkomende opmerkingen kunnen hier genoteerd worden.

7. Vanuit welke professionele rol nam u deel aan de focusgroep? *

Markeer slechts één ovaal.

- ◯ Huisarts
- ◯ Huisarts-in-opleiding (HAIO)
- ◯ Vertegenwoordiger van één van de deelnemende bedrijven
- ◯ Vertegenwoordiger van één van de deelnemende laboratoria

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Retour d'information sur l'étude du POCT-CRP

* Verplichte vraag

1. E-mailadres *

2. Dans quelle mesure êtes-vous d'accord avec l'affirmation suivante: *

Thème 1: CRP POCT aide à résoudre l'incertitude diagnostique: CRP POCT est un outil objectif qui aide à prendre des décisions diagnostiques, en complément de l'intuition et de l'examen clinique. Il est particulièrement utile en cas d'incertitude diagnostique, car il permet de distinguer les infections virales des infections bactériennes. Les médecins ont souligné son utilité dans diverses indications et contextes cliniques, en particulier chez les enfants, car il s'agit d'une méthode moins invasive pour évaluer la gravité de l'infection.

Markeer slechts één ovaal.

- ◯ Pas du tout d'accord
- ◯ Pas d'accord
- ◯ Plûtot pas d'accord
- ◯ Plûtot d'accord
- ◯ D'accord
- ◯ Tout à fait d'accord

3. Dans quelle mesure êtes-vous d'accord avec l'affirmation suivante: *

Thème 2: intégration transparente dans leur flux de travail, souci de la qualité, de l'assistance et de la facilité d'utilisation sont considérés comme primordiaux: Le test a généralement été bien intégré dans le flux de travail des médecins généralistes, qui ont trouvé des moyens de faire plusieurs choses à la fois pendant le court temps d'attente. Les médecins généralistes ont souligné l'importance d'un contrôle de qualité rigoureux et d'un soutien constant de la part des laboratoires et des fabricants d'appareils pour résoudre les problèmes d'installation et les difficultés techniques, lors de la mise en œuvre à grande échelle des appareils de CRP. La rapidité et la simplicité de l'appareil, ainsi que le peu d'échantillon de sang nécessaire, ont été soulignés comme étant ses caractéristiques les plus importantes.

Markeer slechts één ovaal.

- ◯ Pas du tout d'accord
- ◯ Pas d'accord
- ◯ Plûtot pas d'accord
- ◯ Plûtot d'accord
- ◯ D'accord
- ◯ Tout à fait d'accord

4. Dans quelle mesure êtes-vous d'accord avec l'affirmation suivante: *

Thème 3 : Un outil de prise de décision à portée de main pour améliorer la communication avec les patients: Bien que le CRP POCT ait aidé à confirmer ou à réévaluer les diagnostics, les médecins ont insisté sur le fait qu'il devait renforcer et non remplacer le jugement clinique. Les médecins ont indiqué que le CRP POCT pouvait avoir contribué à réduire les prescriptions inutiles d'antibiotiques, en leur donnant une plus grande confiance dans le fait de ne pas prescrire d'antibiotiques. En outre, le test améliore la communication avec les patients, ce qui permet de justifier plus facilement l'abstention d'antibiotiques tout en rassurant les patients. Le test a également encouragé la collaboration, en incitant à des co-consultations lorsque les résultats n'étaient pas concluants.

Markeer slechts één ovaal.

- ◯ Pas du tout d'accord
- ◯ Pas d'accord
- ◯ Plûtot pas d'accord
- ◯ Plûtot d'accord
- ◯ D'accord
- ◯ Tout à fait d'accord

5. Dans quelle mesure êtes-vous d'accord avec l'affirmation suivante: *

Thème 4 : Coût et remboursement: un facteur crucial pour une adoption & utilisation à grande échelle: L'absence d'un modèle de remboursement structuré a été identifiée comme un obstacle majeur à une mise en œuvre plus large. Bien que certains médecins généralistes aient exprimé leur volonté d'investir dans l'appareil, le coût des cartouches de test reste une préoccupation.

Markeer slechts één ovaal.

- ◯ Pas du tout d'accord
- ◯ Pas d'accord
- ◯ Plûtot pas d'accord
- ◯ Plûtot d'accord
- ◯ D'accord
- ◯ Tout à fait d'accord

6. Tout commentaire supplémentaire peut être noté ici.

7. Dans le cadre de quelle fonction professionnelle avez-vous participé au groupe de discussion? *

Markeer slechts één ovaal.

- ◯ Médecin généraliste
- ◯ Médecin généraliste en formation
- ◯ Représentant d'une des entreprises participantes
- ◯ Représentant d'un des laboratoires participants

8. Persoonlijke reflectie

8.1 Persoonlijke reflectie Lauren

Aan het begin van ons traject als huisarts-in-opleiding, waren Frauke en ik al snel overtuigd dat we graag samen het proces van de masterthesis zouden doorlopen. We kenden elkaar al meerdere jaren als goede vrienden en hadden ook reeds in het verleden samengewerkt, hetgeen altijd aangenaam en constructief verliep. We bespraken vooraf grondig onze persoonlijke verwachtingen en gewoonten met betrekking tot een wetenschappelijk werk van deze aard en hieruit bleek dat we beiden veel waarde hechten aan dezelfde zaken namelijk stiptheid, grondigheid, kwaliteit en een goede planning. Vanuit een gemeenschappelijke insteek kozen we voor een thesis met één gemeenschappelijke onderzoeksvraag/probleemstelling en werkten we dus samen aan één definitieve scriptie.

We begonnen samen te brainstormen over een mogelijk onderwerp en vonden het hierbij belangrijk dat het zou gaan over iets dat actueel is en dat de huidige wetenschap binnen de eerste lijn vooruit zou kunnen helpen. Uiteindelijk kwamen we op basis van onze eigen voorstellen terecht in een doctoraatsproject rond antibioticaresistentie onder leiding van promotor prof. Dr. Jan Verbakel en co-promotor Annelien Dankaerts, waarbij we ons uiteindelijk voornamelijk gefocust hebben op het onderzoek rond de implementatie van CRP POCT in de eerste lijn bij volwassen patiënten met acute hoest. We kregen tijdens dit project de kans om ook met andere betrokken onderzoekers en studenten samen te werken hetgeen ons veel heeft geleerd en ook onze eigen samenwerking heeft verbeterd.

Vanaf het begin werden de taken die ons werden toegewezen steeds uniform verdeeld. Over het algemeen heb ik ook het gevoel dat de werklast voor beide partijen vergelijkbaar is geweest doorheen het ganse traject. Indien nodig werd er wel de nodige flexibiliteit aan de dag gelegd vanuit beide partijen wanneer er door persoonlijke of familiale redenen bepaalde deadlines moeilijk gehaald konden worden. We konden hierbij ook altijd rekenen op een begripvolle houding van onze co-promotor die ook flexibel met ons in overleg ging over het plannen van deadlines. Natuurlijk heeft iedereen zijn sterke kanten en minder sterke kanten dus de taken werden soms wel opgenomen in functie hiervan. Zo schreef ik bijvoorbeeld een groot deel van de methoden, het abstract en de conclusie terwijl Frauke zich finaal meer bezighield met de vormelijke aspecten van onze masterthesis en de referentielijst, hetgeen ik veel minder sterk in ben. We bleven wel steeds nauw in overleg met elkaar en organiseerden vaak besprekingen onder vier ogen waarbij we de schriftelijke feedback van onze co-promotor en van elkaar bespraken en de nodige aanpassingen deden. Persoonlijk gezien heb ik het werk rond deze masterthesis goed kunnen verdelen over mijn beschikbare tijd door het maken van een grondige planning. Het combineren met werken in de praktijk, andere deadlines en persoonlijke aangelegenheden was, zeker op het einde van het traject, niet altijd gemakkelijk. Door het volgen van een stipte planning is het me echter wel gelukt op een

aangename manier waarbij ik een gezonde balans heb kunnen bewaren tussen (school)werk en vrije tijd.

Ik ben uiteindelijk zeer trots op het onderzoek dat we mee gevoerd hebben en op de scriptie die we hebben kunnen realiseren. De bezorgdheid rond antimicrobiële resistentie en de uitdagingen hieromtrent zijn alom aanwezig in het medische landschap en wij als huisarts worden ook bijna dagelijks geconfronteerd met casussen waarbij we voor een keuze staan om antibiotica te starten of niet. Bij twijfelgevallen helpt een CRP-waarde ons vaak om in te schatten of het opstarten van antibiotica nodig is of niet. In tegenstelling tot de ziekenhuiscontext, vraagt het bepalen van een CRP-waarde in de huisartsenpraktijk wel wat tijd aangezien dit via externe laboratoria moet gebeuren. Het gebruik van CRP POCT in de huisartsenpraktijk zou hier de mogelijkheid kunnen bieden om tijdens de consultatie binnen de paar minuten een CRP-waarde te kunnen bepalen om je verdere beleid op af te stemmen. Dit verdere beleid kan breder zijn dan enkel de keuze of er antibiotica gestart moet worden naar mijn gevoel aangezien het ook soms leidend kan zijn in de keuze om een patiënt al dan niet te verwijzen voor verdere onderzoeken. Zoals ook wordt aangehaald door deelnemende huisartsen in ons onderzoek kan de CRP-waarde ook gebruikt worden om patiënten te overtuigen dat er geen opstart van antibiotica noodzakelijk is. Dit mag naar mijn gevoel niet de enige drijfveer zijn om een CRP test uit te voeren, maar kan bij een repetitieve antibioticavraag vanuit een patiënt wel een objectief argument zijn om je conservatief beleid te onderbouwen en onzekerheid bij de patiënt weg te nemen. Ikzelf heb nog nooit een CRP POCT toestel gebruikt in de huisartsenpraktijk, maar in mijn huidige opleidingspraktijk hebben we wel een tijdje actief gemonitord hoe vaak we een CRP aanvroegen via het labo om ons beleid verder vorm te geven. Daaruit bleek dat een CRP-toestel toch in veel verschillende situaties gebruikt zou kunnen worden om een snelle CRP-meting te kunnen uitvoeren om het verdere beleid vorm te geven. Ik zou het gebruik daarom ook graag implementeren in mijn toekomstige praktijk omdat ik er echt wel voordelen in zie voor alle partijen en dit in diverse indicaties.

Ons onderzoek geeft inzicht in hoe huisartsen de implementatie in de dagdagelijkse praktijk hebben ervaren. Dit heeft zeer waardevolle inzichten naar voren gebracht over welke barrières er momenteel nog aanwezig zijn die aangepakt moeten worden om een toekomstige uitrolling van CRP POCT in de Belgische eerste lijn mogelijk te maken. Het is dan ook op deze manier dat de resultaten van onze studie leidend kunnen zijn voor toekomstig onderzoek over CRP POCT in de huisartsenpraktijk. De zaken die hierbij vooral nog bekeken moeten worden zijn de perikelen rond financiering en terugbetaling, het al dan niet opstellen van een nationale richtlijn over het interpreteren van CRP-waarden in de eerste lijn en het uitbouwen van gestandaardiseerde ondersteuningssystemen voor gebruikers van CRP POCT toestellen.

We zijn dus zeker nog niet op het eindstation en er moeten nog een heel aantal factoren geëvalueerd worden, maar dat het verhaal en de potentie van CRP POCT in de huisartsenpraktijk hier niet stopt,

lijkt me duidelijk. Ik kijk alvast met veel nieuwsgierigheid uit naar volgende publicaties en ontwikkelingen!

8.2 Persoonlijke reflectie Frauke

Onze thesis kwam tot stand binnen de context van een breder doctoraatsonderzoek rond antibiotica therapiefalen. Lauren en ik werden betrokken bij verschillende onderdelen van het onderzoek, waardoor we konden proeven van zowel kwalitatieve als kwantitatieve onderzoeksmethoden. We hielpen onder andere bij: screening van artikels over antibiotica therapiefalen volgens in- en exclusiecriteria, oplijsten van relevante comorbiditeiten en soorten infecties waar antibiotica voor gegeven kan worden en deze vervolgens koppelen aan ICD-10 en ICPC-2 codes... Het was me al snel duidelijk dat het kwalitatieve luik me meer interesseerde. Hoewel statistisch onderzoek heel belangrijk is, vind ik het ook veel drogere materie en leunt het minder aan bij onze job als huisarts.

Het grootste aandeel van ons werk situeerde zich binnen het onderdeel dat gebruik maakte van focusgroep discussies om meer inzicht te krijgen in de percepties van huisartsen ten aanzien van CRP POCT. Dit is bovendien het onderdeel waarop onze thesis gebaseerd is. We stonden in voor het transcriberen van de focusgroepen, de thematische analyse en uiteindelijk ook het schrijven van de thesis zelf. Dit werk werd zo eerlijk mogelijk verdeeld, waarbij ieder van ons zich vooral kon toeleggen op de taken waarin zij het sterkst was. We maakten telkens eerst een opsomming en structuur van de onderwerpen die we wilden bespreken, waarna we elk afzonderlijk een onderdeel uitwerkten. Nadien keken we elkaars teksten na, voegden we alles samen en werkten we het uit tot een coherent geheel. De introductie, resultaten en discussie werden gelijk verdeeld. De methode werd grotendeels door Lauren geschreven, terwijl ik me eerder toelegde op de vormelijk aspecten, zoals de opmaak en bronvermelding, en de presentatie.

De samenwerking met Lauren verliep zeer vlot, vermoedelijk omdat we elkaar vooraf al goed kenden als vrienden. Het was duidelijk dat we beiden onze eerlijke mening durfden uiten, ook wanneer deze eerder kritisch was. We hanteerden een duidelijke, maar ook diplomatische manier van communiceren, waardoor niemand zich aangevallen voelde. Ik kan stellen dat we na het schrijven van de thesis minstens even goede vrienden gebleven zijn. We overlegden regelmatig via sms en na elk groter tekstgedeelte planden we een video call. Naar het einde van de thesis toe spraken we vaker fysiek af, waarbij ik merkte dat dit vaak vlotter verliep. Ook de samenwerking met onze co-promotor Annelien en andere medestudenten verliep vlot.

Persoonlijk vond ik het soms een uitdaging om deze thesis te schrijven in combinatie met mijn werk als huisarts in opleiding. Het vergde goede planningsvaardigheden en duidelijke afspraken, de welke ik voorafgaand aan de thesis misschien minder bezat. Vroeger betrapte ik mezelf er vaak op om dingen uit te stellen tot op het laatste moment, iets wat in dit geval niet mogelijk was gezien de samenwerking met een andere student. Ik kan dan ook stellen dat ik geleerd heb om meer volgens een planning te werken en dat deadlines mij effectief helpen om minder uit te stellen.

Inhoudelijk denk ik dat ons werk bepaalde belangrijke inzichten heeft opgeleverd. Zo bleek dat de meeste huisartsen positief staan tegenover het gebruik van CRP POCT. Wetenschappelijk onderzoek toonde bovendien aan dat het kan zorgen voor een gedeeltelijke reductie in antibioticumvoorschriften en bijgevolg in antimicrobiële resistentie. Momenteel is CRP POCT nog niet geïntegreerd in Belgische richtlijnen. Ik ben van mening dat dit een meerwaarde zou zijn voor de eerste lijn, zeker indien een (gedeeltelijke) terugbetaling wordt voorzien. Ik denk echter wel dat het gebruik van CRP POCT enkel een verbetering van het voorschrijfgedrag kan teweegbrengen indien er ook duidelijke richtlijnen worden ontwikkeld en (huis)artsen een adequate opleiding krijgen omtrent het gebruik en de interpretatie van CRP POCT in verschillende contexten. Zoals ook uit onze focusgroepen bleek, denk ik dat het van primordiaal belang blijft dat we als huisarts blijven steunen op een grondige anamnese, klinisch onderzoek en het bijhorende buikgevoel. Het routinematig uitvoeren van CRP POCT is volgens mij dan ook geen oplossing, het blijft slechts een hulpmiddel binnen een breder klinisch beslissingsproces.

In de praktijk waar ik momenteel werk, maken we eveneens gebruik van een CRP toestel. Ik merk dat mijn redenen om CRP POCT toe te passen in lijn liggen met wat de huisartsen uit de focusgroepen aangeven. Hoewel ik nog een jonge huisarts ben, probeer ik mijn buikgevoel te volgen en de test enkel te gebruiken bij diagnostische onzekerheid. Anderzijds merk ik dat het deels ook helpt bij het ontwikkelen van mijn buikgevoel, aangezien het de juistheid van mijn klinisch redeneren objectief aftoetst. Bovendien merk ik op dat je best op voorhand bepaalt wat de meerwaarde kan zijn van de CRP test. Als je klinisch al de inschatting maakt dat antibiotica moet gegeven worden, of net niet, dan kan je best enkel hierop verder bouwen. Een CRP resultaat in een duidelijke klinische context heeft bij mij al eerder voor meer verwarring/onduidelijkheid gezorgd.

Aangezien patiënten in onze praktijk de test zelf moeten betalen, vormt dit soms een drempel voor toepassing bij patiënten met minder financiële middelen. In die gevallen maak ik vaker gebruik van een veneuze bloedafname. Ik ben dan ook voorstander van een (gedeeltelijke) terugbetaling, aangezien zo de ongelijkheid van zorg kan worden vermeden. Op lange termijn zal het hopelijk zelfs zorgen voor besparingen binnen de gezondheidszorg, door een vermindering in antibiotica voorschriften en antimicrobiële resistentie. Een voorwaarde voor deze financiële tegemoetkoming, is uiteraard wel een duidelijk kader waarbinnen huisartsen dienen te werken, met afgebakend gebruik van CRP POCT. Ik denk wel dat het erg moeilijk is om op voorhand aan te tonen dat het 100% zeker een reductie in gezondheidszorguitgaven en antimicrobiële resistentie zal betekenen, aangezien beide ook van vele andere factoren afhankelijk zijn.

Tot slot vind ik CRP POCT niet alleen interessant binnen mijn eigen praktijkvoering of als beslissingsondersteuning. Deze thesis heeft me doen inzien dat je als huisarts ook een belangrijke maatschappelijke verantwoordelijkheid draagt, waaronder het bewaken van antimicrobiële resistentie. Alles wat ik als individuele huisarts beslis heeft namelijk een impact op de algemene volksgezondheid. In de praktijk waar ik momenteel werk, zullen we binnenkort deelnemen aan de

PaSSo-studie, een studie die het voorschrijfgedrag van huisartsen tracht te analyseren en antibiotica stewardship wenst te vergroten middels beslissingsondersteunende tools. Deze zal ons hopelijk nog bewuster maken van ons antibiotica gebruik en ons bijsturen waar nodig. Ik kijk alvast uit naar de komende nieuwe ontwikkelingen en toepassingen van POCT-testing in de eerstelijnszorg.