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**Evaluation of utilization and consequences of CRP point-of-care-testing in
primary care practices: qualitative interviews with General Practitioners from
Germany**

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1 **Abstract**

2 **Background**

3 The use and advantages of point-of-care tests (POCTs) for C-reactive protein (CRP) in general practice,
4 especially for upper respiratory tract infections (uRTIs), have been studied extensively. However, there
5 is limited knowledge about test indications, prerequisites, and integration of these tests into everyday
6 practice.

7 **Aim**

8 This study aims to investigate the attitudes and experiences of general practitioners (GPs) in Germany
9 regarding the use of semi-quantitative CRP-POCTs. The study places special emphasis on
10 implementation in routine care, including testing procedures, feasibility, opportunities and barriers for
11 specific consultation scenarios, as well as test indications and their impact on GP-patient
12 communication.

13 **Design and setting**

14 Qualitative interview study with 10 GPs (May/2023 to Aug/2023)

15 **Methods**

16 Ten German GPs who participated in an observational study on CRP-POCT use in general practices
17 were interviewed using semi-structured interviews. Audio recordings were transcribed and content
18 analysis was performed.

19 **Results**

20 Interviewed GPs stated that CRP-POCTs offer several advantages for various treatment cases. They
21 improve diagnostic confidence and certainty of GPs' therapeutic decisions, and offer a broad spectrum
22 of indications and application scenarios. Additionally, they have a positive impact on GP-patient
23 communication, and their ease of use enables rapid implementation into existing workflows. On the
24 other hand, CRP-POCT increase the time required for test performance and patient consultation.

25 **Conclusion**

26 Due to the numerous benefits of semi-quantitative CRP-POCTs, interviewed GPs have a favourable
27 attitude towards their regular integration into everyday practice. Implementation barriers include
28 increased time and personnel expenses for testing and inadequate reimbursement by German
29 statutory health insurance.

30 **Keywords:** C-reactive protein, interviews, point-of-care testing, primary care, general practice

31 **How this fits in**

32 Measurement of C-reactive protein (CRP) can give general practitioners (GPs) a first impression of
33 whether an infectious or inflammatory disease is present in the patient. Point-of-care tests (POCTs)
34 can accelerate diagnostic and support clinical decision-making of GPs. Despite being widely used in
35 many countries, CRP-POCTs are not commonly used in German general practices.

36 This study presents qualitative data on indications, diagnostic goals and clinical consequences of semi-
37 quantitative CRP-POCTs in routine primary care. GPs find the use of CRP POCTs easy to implement in
38 daily routine and beneficial due to positive effects on patient interaction.

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39 **Introduction**

40 Patient-near Point-of-care tests (POCTs) gain more importance in primary care. Their results are
41 available within a few minutes and improve diagnostic as well as therapeutic decisions. Contrary to
42 diagnostic accuracy of POCTs, their therapeutic consequences, feasibility, and successful integration
43 into daily practice are much less studied [1-3].

44 POCTs measuring C-reactive protein (CRP) can provide information on the extent of infectious diseases
45 and can support the differentiation between bacterial and viral infections [4]. Thus, CRP-POCT support
46 rational antibiotic prescribing in respiratory tract infections (RTIs) in primary care [1, 4-7], and help to
47 reduce antibiotic resistance [8, 9].

48 Previous publications mainly focused on factors contributing to the use of CRP-POCTs in RTIs [10-15].
49 There is limited evidence on the utilization of CRP-POCTs by general practitioners (GPs) for other
50 conditions such as gastrointestinal (GIs) or urinary tract infections (UTIs), and for monitoring therapy
51 or disease progression. In outpatient emergency medical services, CRP POCTs also showed benefits
52 also for GIs and UTIs [16]. Only about 20% of GPs in Germany currently use CRP-POCTs [18, 19],
53 probably since reimbursement by statutory health insurance does not cover costs. However, the
54 increasing workload of GPs and the need for adequate diagnostic in infectious diseases could be solved
55 by an expansion of CRP-POCTs in the German primary care setting.

56 This study aimed to provide insights on general testing procedures, feasibility and integration into
57 practice workflows, test occasions, barriers and promoting factors for POCT use, and influence on GP-
58 patient-communication.

59

60 **Study design and research methods**

61 This qualitative study was conducted as part of a prospective multicentre observational study with
62 1.740 semi-quantitative CRP-POCTs performed in 49 German primary care practices (German Clinical
63 Trials Register: DRKS00030333), and was funded by the German Federal Ministry of Education and
64 Research (01GK1902) as part of the RESPoNsE practice-based research network [20]. We conducted
65 semi-structured interviews on CRP-POCT use with ten GPs [21, 22], who had participated in the
66 observational study. The study followed the COnsolidated criteria for REporting Qualitative research
67 (COREQ) (Supplementary Table 1) [23].

68 **Recruitment**

69 Interview partners were recruited via personal, telephone and e-mail contacts. There were no other
70 specific inclusion/exclusion criteria. Participants were provided with a financial compensation (EUR
71 100).

72 **Conducting the interviews**

73 A guide for the semi-structured interviews and a questionnaire were developed by the researchers
 74 (Supplementary Boxes 1 and 2), considering domains and selected constructs of the updated
 75 Consolidated Framework for Implementation Research (CFIR) [24] (Supplementary Table 2). Not all
 76 constructs of the different domains could be addressed due to the extent of information. The proposed
 77 questions of the CFIR Guide were not fully suitable for the objectives of our interviews. In addition, we
 78 had already gained insights from the data collection sheets (observational part of the study) and
 79 wanted to avoid redundancies in certain CFIR constructs. Yet, all five CFIR domains and several
 80 constructs were incorporated into the selection of our main categories. Two physicians piloted the
 81 interview guide. All interviews were conducted by the first author between May and August 2023
 82 either face-to-face in practices or as online meetings.

83 **Data collection and processing**

84 Audio recordings were used for data collection. Field notes were taken immediately after each
 85 interview. No further information was obtained in the last three interviews (nos. 8 to 10), so that a
 86 thematic saturation was assumed [25]. Interviews were recorded, pseudonymised and transcribed
 87 using F4X-software. Transcripts were not returned for commenting/correction.

88 **Analysis**

89 Since the updated CFIR does not provide a template for evaluation with the software MAXQDA (version
 90 2022) [26], we performed a content analysis according to Kuckartz [27] instead. Eight main categories
 91 were deductively derived from the interview guide, supplemented by inductively formed
 92 subcategories. The category system used is shown in Fig. 1. Each text segment was assigned to a
 93 maximum of one subcategory per interview. For validity analysis we calculated intra-coder and inter-
 94 coder reliability [28].

95

96 **Fig. 1**

97 *Figure 1: Illustration of the category system used. The eight main categories and exemplary subcategories for "positive*
 98 *aspects of testing" in MAXQDA 2022 are shown. Matching CFIR domains are shown in green.*

99

100 **Results**

101 Characteristics of the participants are shown in Table 1. Respondents had between 2.5 and 30 years of
 102 working experience as GP and worked in practices in Thuringia (n = 8) and Berlin (n = 2). The majority
 103 were female (n = 7). Interviews lasted between 12:47 and 29:33 minutes. Seven GPs surveyed stated
 104 that they had not used CRP-POCTs within their practice prior to the observational study.

105

Parti- cipant	Practice location according to BBSR*	Gender	Age in years	Work experience as GP (years)	Location of the interview	Duration of the interview (min:sec)
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P1	large city	♀	61	16	practice	23:37
P2	large city	♀	55	17	practice	16:05
P3	small town	♂	40	6	practice	17:51
P4	large city	♂	62	30	online	29:33
P5	medium-sized town	♀	37	2,5	practice	18:45
P6	medium-sized town	♀	52	20	online	25:26
P7	rural community	♂	37	3	online	20:17
P8	large city	♀	65	30	practice	17:13
P9	large city	♀	42	5	online	15:37
P10	large city	♀	55	13	practice	12:47
		n=7 (70%) ♀, n=3 (30%) ♂	Average: 50,6	Average: 14,25	n=6 (60%) Practice, n=4 (40%) online	Average: 19:43

106 *Table 1: Overview of the characteristics of the respondents. *BBSR: Federal Institute for Research on Building, Urban Affairs*
 107 *and Spatial Development. Categories: rural community < 5.000 inhabitants; small town 5.000 – 19.999 inhabitants; medium-*
 108 *sized town 20.000 – 99.999 inhabitants; large city 100.000 and more inhabitants, GP: general practitioner.*

109 Procedures for testing and modifying practice workflows

110 Conducted interviews showed, that there were differences in CRP-POCT-use and procedures between
 111 practices. Both professions, GPs and medical assistants (MAs), decided, either individually or together,
 112 whether the test was carried out. Tests were never conducted solely by GPs, as MAs were always
 113 involved or carried out the tests independently. Turnaround time including evaluation ranged from
 114 three to 25 minutes.

115 Although almost all respondents stated that the tests had

116 *„not really brought any major changes in the practice workflows‘ (P7),*

117 additional time was required whenever POCTs were performed:

118 *„Of course, I then had to see a patient a second or third time, which [otherwise] would not have*
 119 *been the case. [...]. The testing time prolonged the patient's consultation.‘ (P9)*

120 Some respondents also mentioned that planning for a follow-up appointment or avoiding it as a
 121 consequence of testing caused additional time expenditure. This contrasts with later mentioned time
 122 savings due to accelerated test results and treatment decisions.

123 Most respondents found it easy to integrate the tests into practice routines. The need for well-trained
 124 MAs and improvements in organization, billing and planning were also mentioned. One respondent
 125 suggested that

126 *„you [would] have to organize it in such a way that right at the beginning of the consultation*
 127 *[...] if someone comes with an infectious disease [...] you already perform the test.‘ (P5)*

128 High costs and handling as negative aspects of tests

129 Initially, negative aspects as well as difficulties with testing, and barriers to regular use, were not
 130 explicitly addressed. When asked, the participants described the reimbursement as inadequate and
 131 some demanded simplified handling.

132 *„It was difficult to handle the pipette.“ (P7)*

133 In contrast to the rapid availability of test results, which was viewed positively, the additional staff and
 134 time required to perform the test in the practice were viewed negatively:

135 *„It is of course [...] an additional examination [...]. Practice time [...] is blocked and someone is
 136 busy.“ (P1)*

137 Testing occasions and reasons

138 Patients' age and medical history were often considered when deciding to perform a CRP-POCT.
 139 Therefore, patients were categorized by the evaluators as high-risk (> 70 years,
 140 multimorbid/chronically ill), adult (>18 and <70 years) and paediatric. Primary purpose of CRP-testing
 141 was to differentiate between bacterial and viral infections. Suspected areas of infection were mainly
 142 RTIs, occasionally UTIs. Symptoms that prompted testing included fever, unspecific complaints, poor
 143 general condition, high disease burden, or gastrointestinal complaints:

144 *„infections, sometimes abdominal pain, [...] unclear symptoms, malaise [...], poor general
 145 condition. [We tested] patients [...] with a previous illness, lung disease, COPD or asthma.“ (P6).*

146 Abnormal auscultation findings, cough, irritated mucosa, and swollen lymph nodes were mentioned at
 147 least once.

148 The tests were also conducted due to organizational constraints, such as limited laboratory availability
 149 on weekends:

150 *„Lab drivers come every day, but if [...] someone comes [afterwards,] the result of a lab test
 151 would only be available days later.“ (P4)*

152 In these cases, diagnostic confidence was needed to clarify whether it was safe to for the patients to
 153 delay further clinical intervention or if therapeutic measures should be initiated promptly.

154 Benefits of tests in communication, diagnostic and therapeutic confidence and patient safety and 155 satisfaction

156 Tests were seen as useful for communicating with patients. For example, patients' preferences for or
 157 against antibiotics could be discussed more specifically, and a (non-)prescription could be justified
 158 more easily.

159 *„For patients who [...] wanted an antibiotic it was good for communication. I could state: „We
 160 have no evidence of a bacterial infection [...] the antibiotic [makes] no sense.““ (P2)*

161 Based on better communication there were also reported increases in patient compliance. All of the
 162 interviewees stated at least once, that testing had benefits on their diagnostic and therapeutic
 163 confidence. They used it

164 *'Sometimes simply to confirm the first impression. So the test is not only organizationally*
165 *preferable, but also when I say I'm not sure.'* (P9)

166 Additionally, satisfaction of the patients

167 *('They found [...] it really great [...] that we could examine them and say this is bacterial, this is*
168 *viral.'* (P5))

169 as well as a direct impact on the patient-safety

170 *('There were two hospital admissions, which we, did more quickly than we might otherwise*
171 *have done.'* (P10))

172 were reported. Time savings due to fast test results were also mentioned:

173 *,The speed of the result, that's fantastic. [...] It was great having a result straight away and to*
174 *be able to react immediately.'* (P5)

175 This goes along with the aforementioned organizational constraints, leading to testing.

176 Patient-feedback and clarification of tests

177 Prior testing, GPs often explained the background, significance, and limitations of the rapid test to their
178 patients. However, patients were rarely involved in the decision to undergo POC-testing. The GP's
179 assessment and the expected benefits for subsequent diagnosis and treatment were primary
180 considerations:

181 *,It's difficult to leave freedom to decide. If I [...] come to the conclusion that I need the [..., test],*
182 *then I'll do it.'* (P7)

183 After testing, however, there was

184 *,always [...] positive feedback.'* (P2)

185 Further implementation of the tests

186 All GPs interviewed stated that they could imagine using CRP-POCTs beyond the scope of the study:

187 *,I continue using them because they are simple, integration is practiced and they give quick*
188 *information - you have a decision within a quarter of an hour.'* (P7)

189 Some respondents mentioned using the tests for home visits and out-of-hours outpatient services.

190 Two GPs already introduced quantitative automated CRP-POCTs in their practice because of the many
191 advantages in general. However, semi-quantitative POCTs are seen as a useful alternative, for example
192 during home visits, as the trend of the value can often provide a basis for further assessment:

193 *,Organizationally, it is also quite exciting when someone just wants a follow-up check to see if*
194 *the CRP is going down [...]. It would be good to have more precise numbers, quantitatively. But*
195 *it was actually sufficient to have a rough direction.'* (P7)

196

197 **Discussion**

198 **Summary**

199 This qualitative interview study conducted with ten German GPs from Thuringia (n = 8) and Berlin (n =
200 2) indicates that semi-quantitative CRP-POCTs can be easily integrated into daily practice and add value
201 to the diagnosis and management of patients with various types of infections. Utilization of the test
202 promotes patient communication and has a time-saving effect on the duration of treatment in
203 practice. However, barriers of adoption include the ease of use of the CRP-POCT and inadequate
204 reimbursement.

205 Overall, CRP-POCTs were perceived as beneficial due to their feasibility and the rapid availability of
206 results. Their use improved communication with patients regarding indication and performance, and
207 offers information gain for further diagnosis and treatment leading to enhanced treatment safety for
208 GPs and patients. The testing procedure varied between practices in terms of personnel and time.
209 However, testing was generally delegated as none of the GPs interviewed reported performing the
210 tests in person.

211 **Strengths and limitations**

212 The interviews were conducted shortly after the completion of the observational study, which helped
213 to minimize recall bias and allowed interviewed GPs to report on actual experiences. Data analysis
214 showed high levels of both, inter-coder (kappa according to Brennan and Prediger = 0.88) and intra-
215 coder reliability (0.96), indicating valid interpretation. Other strengths are the direct mapping of
216 physicians' opinions regarding the utilization of the tests, the identification of benefits and barriers,
217 and the presentation of substantive, inductively collected ratings. Not all CFIR constructs could be
218 integrated into our category system, but care was taken to ensure that all five CFIR domains were
219 proportionally reflected in our main and subcategories (Figure 1).

220 There are few limitations to our study. Regarding the sampling, it is important to note that participants
221 were pre-selected, which may have positively influenced the results. Although the interviewees were
222 informed that their answers were pseudonymised, it is still possible that social desirability bias may
223 have influenced their responses. Additionally, the time period of the observational study (10/22 to
224 04/23 = cold and flu season) increases the probability of RTIs.

225 **Comparison with existing literature**

226 Several studies have demonstrated the benefits of CRP-POCTs in primary care. These benefits include
227 reduced antibiotic prescriptions and improved treatment safety in RTIs [1, 4-7]. Our results align with
228 previous studies from across Europe, which have shown a positive perception of GPs towards POCTs
229 [29, 30]. Semi-quantitative CRP-POCTs were found to be sufficient in categorizing unclear symptoms
230 and distinguishing between viral and bacterial infectious genesis. Despite the lower analytical
231 performance of CRP-POCT [31, 32], the interviewed GPs appeared to accept concentration ranges
232 instead of exact numerical values. From the GPs' perspective, semi-quantitative POCTs could be easily
233 integrated into existing practice workflows and the concentration range gave a sufficient orientation

234 for further procedure. CRP-POCTs were perceived as very useful due to their simplicity, delegability,
235 and support with communication regarding indication and performance. Rapid availability of the test
236 result, high information gain for further diagnostics and treatment, and increased treatment safety for
237 GPs and patients are further advantages brought by the tests. Based on the interviews with GPs, CRP-
238 POCTs were found to be especially beneficial for older patients with multiple health conditions and for
239 children, but current studies do not support the use of CRP-POCTs to reduce antibiotic prescriptions in
240 children with RTIs [33, 34]. However, POCTs can alleviate stressful uncertainty among GPs and parents.
241 Consistent with existing literature, interviewed GPs mentioned handling and interpretation difficulties,
242 additional time, and labour required for testing as negative aspects [18, 19, 35]. Previous studies have
243 confirmed that German GPs are highly willing to delegate tasks to qualified MAs [36, 37]. This also
244 relates to the execution of CRP-POCTs. It remains unclear whether POCTs cumulatively save or extend
245 time. Another obstacle specific to primary care in Germany is the lack of cost-covering reimbursement.
246 While there are positive aspects, such as subjective time and resource savings, and perceived benefits
247 from the user's perspective, it is important to note that cost-effectiveness has already been proven for
248 RTIs [38], supporting the demand for cost-covering reimbursement.

249 Interestingly, interviewed GPs also used CRP-POCTs in suspected diagnoses other than RTIs. Available
250 evidence in this regard is limited. Conducted studies lack information whether GPs diagnostic accuracy
251 is affected and whether treatment decisions supported by CRP-POCTs improve patient safety in cases
252 other than RTIs. Accordingly, the potential risk of the technology needs to be addressed in future
253 implementation efforts. However, our findings are of importance for the establishment of semi-
254 quantitative CRP-POCTs in the German primary care setting.

255 Overall, it is evident that the benefits of CRP-POCTs outweigh potential drawbacks. This aligns with the
256 findings of the observational part of our study [20]. In both our observational study and qualitative
257 interviews, we demonstrated that the use of CRP-POCT enhances clinical decision-making and
258 increases the clinical confidence of GPs. Furthermore, the reasons for testing and differential diagnoses
259 were comparable across the majority of cases, which involved not only RTIs, but also GIs and UTIs.
260 Further studies are necessary to establish appropriate scenarios for the use of CRP-POCTs in general
261 practice. Our interviews indicate that GPs do not perform shared-decision-making regarding the use
262 of CRP-POCTs. Therefore, additional research is needed to incorporate the patient's perspective.

263 **Implications for practice**

264 German GPs consider semi-quantitative CRP-POCTs to be valuable diagnostic tools due to their ability
265 to facilitate immediate clinical decisions when compared to conventional laboratory testing. Utilization
266 can increase diagnostic and therapeutic certainty in decision-making. The integration of these tests
267 into practice is considered simple, with no significant barriers to routine use. Adjusting reimbursement
268 to cover the costs of tests could increase their utilization among GPs in Germany. All respondents

269 expressed their willingness to continue using the tests in their practice, some of them only if provided
270 with cost-covering reimbursement. Further studies are needed to determine the validity and objective
271 benefits of semi-quantitative POCTs in primary care.

272

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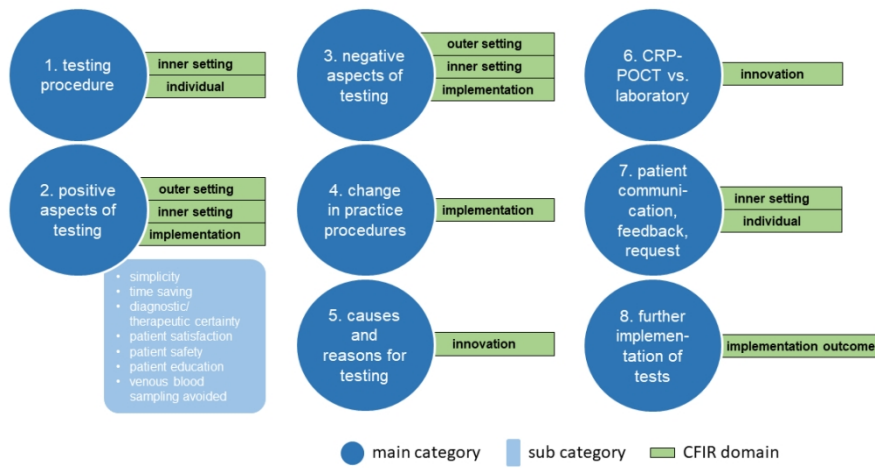


Figure 1: Illustration of the category system used. The eight main categories and exemplary subcategories for "positive aspects of testing" in MAXQDA 2022 are shown. Matching CFIR domains are shown in green.

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