

RESEARCH

Open Access



# Identifying psychosocial and contextual markers considered by physicians to personalize care

Paul Domenach<sup>1,2</sup>, Karolin R. Krause<sup>1</sup>, Alexandre Malmartel<sup>1,3</sup>, Philippe Ravaud<sup>1,4,5</sup> and Viet-Thi Tran<sup>1\*</sup>

## Abstract

**Background** The objective of the study was to identify the psychosocial and contextual markers considered by physicians to personalize care.

**Methods** An online questionnaire with one open-ended question, asking physicians to describe clinical situations in which they personalized care, was used. Physicians were recruited from March 31, 2023, to August 10, 2023, from three hospitals, five university departments of general practice and six physician organizations in France. Recruitment was conducted through email invitations, with participants encouraged to invite their colleagues via a snowball sampling method. The participants were a diverse sample of French general practitioners and other medical specialists who see patients in consultations or in hospital wards. We extracted the psychosocial and contextual markers considered by physicians to personalize care in each clinical situation. The analysis involved both manual and AI-assisted content analysis using GPT3.5-Turbo (OpenAI). Mathematical models to assess data saturation were used to ensure that a comprehensive list of markers was identified.

**Results** In total, 1340 people connected to the survey platform and 1004 (75.0%) physicians were eligible for the study (median age 39 years old, IQR 34 to 50; 60.5% women; 67.0% working in outpatient settings), among whom 290 answered the open-ended question. The participants reported 317 clinical situations during which they personalized care. Personalization was based on the consideration of 40 markers: 27 were related to patients' psychosocial characteristics (e.g., patient capacity, psychological state, beliefs), and 13 were related to circumstances (e.g., competing activities, support network, living environment). The data saturation models showed that at least 97.0% of the potential markers were identified. Manual and AI-assisted content analysis using GPT3.5-Turbo were concordant for 89.9% of clinical situations.

**Conclusions** Physicians personalize care to patients' contexts and lives using a broad range of psychosocial and contextual markers. The effect of these markers on treatment engagement and effectiveness needs to be evaluated in clinical studies and integrated as tailoring variables in personalized interventions to build evidence-based personalization.

**Keywords** Personalized medicine, Precision medicine, Evidence-based medicine, Personomics, Clinical decision-making

\*Correspondence:

Viet-Thi Tran

thi.tran-viet@aphp.fr

Full list of author information is available at the end of the article



© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

## Background

The current system of evidence, on which clinical practice guidelines are based, assesses average treatment effects at the population level [1]. However, there is heterogeneity in patients' engagement with and response to treatment, and clinicians must adapt study results to individual patients by drawing on their clinical expertise and accounting for patients' circumstances, characteristics, values, and preferences [2, 3]. Recently, the UK National Health Service (NHS) published a novel guideline for personalized care and support planning [4]. While this guideline encourages a departure from "one size fits all" approaches, it stops short of identifying which specific patient characteristics and circumstances clinicians should consider when personalizing care and how. Several studies aimed at helping physicians practice the "Art of Medicine" (i.e., the compassionate and holistic consideration of patients as individuals based on the patient-clinician relationship) have suggested broad themes that should be discussed in clinical encounters (e.g., access to care, competing responsibilities). However, none has identified the precise and fine-grained "psychological, social, cultural, behavioral, and economic factors that influence response to treatment," that have been termed "personomics," that affect (1) whether an intervention is required or not, (2), if so, which intervention and (3) the modalities of its implementation (duration, content, etc.). Understanding the precise markers used by physicians to personalize care has the power to expand the concept of personalized medicine beyond biological elements, such as genomics or proteomics, and to allow the transition from personalization of care that is experience-based to evidence-based personalization [5]. The need for evidence on which elements may affect response to therapeutic interventions can be exemplified by a recent meta-analysis showing that smoking cessation interventions tailored to the socioeconomic status of patients did not actually yield better outcomes for disadvantaged groups, contradicting what many clinicians might believe and invest time into [6].

In this study, we aimed to empirically identify the precise psychological and contextual markers considered by physicians to personalize care for individual patients.

## Methods

We administered an online questionnaire with open-ended questions asking physicians to describe the clinical situations during which they provided personalized care. We followed the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) (Additional file 1: Table S1) [7].

## Participants and recruitment

We recruited French general practitioners and other medical specialists who see patients in consultations or in hospital wards. We excluded specialists not seeing any patients (e.g., biologists and radiologists), medical students, residents, and pharmacists. We recruited participants by sending email invitations to (1) practitioners from Lyon University Hospitals, Medipôle Lyon-Villeurbanne or Assistance Publique des Hôpitaux de Paris (only internal medicine and infectious diseases wards), (2) five departments of General Practice and Family medicine in French universities and, (3) partner physician organizations (e.g., the Regional Union of Health Professionals); as well as from calls for participation shared via professional networks and social media (Additional file 2: Supplementary Method 1 and Additional file 2: Supplementary Method 2). We encouraged participating physicians to invite their colleagues using a snowball sampling method [8, 9]. Our sampling strategy aimed to select a diverse sample of participants with various clinical experiences rather than a representative sample of French-speaking physicians. No financial or nonfinancial incentives were provided to the participants.

This study did not seek to develop biological or medical knowledge (i.e., to evaluate the functioning mechanisms of the human organism, whether normal or pathological, or the efficacy and safety of procedures or the use or administration of products for the diagnosis, treatment, or prevention of pathological conditions), and French law does not classify it as research involving human subjects. Therefore, no ethics committee approval was needed, and the requirement to obtain written informed consent from the participants was waived [10].

## Questionnaire development

One investigator (PD) developed the online questionnaire based on a nonsystematic literature review in PubMed, Google Scholar, Embase, Web of Knowledge, and CINAHL, focusing on both the personalization of clinical care in practice and the tailoring of therapeutic interventions in clinical research. The search used terms such as "personomics," "contextual factors," "medical biography," "patient characteristics," or "patient nonclinical factors." In the literature, several studies have identified themes that should be discussed during clinical encounters to inform goal-based care or shared decision-making [5, 11–17]. However, the themes described were often broad (e.g., access to care, social support, and competing responsibilities) and not precise enough to identify a granular list of patient circumstances and characteristics that play a role in modifying response to treatment.

Development of the questionnaire involved several iterations alternating between the conception and pilot testing phases. Pilot testing involved nine physicians and two medical residents, and the functionality and feasibility of the questionnaire (e.g., time needed, number, and reasons for dropping out) as well as its clarity and comprehensibility were assessed with a double interview method [18]. During this process, one member of the research team (PD) reviewed the questionnaire with the pilot participants and asked them to explain what the question meant to them and why they answered in one way or another. Discrepancies between what was intended and what was understood, with possible modifications, have been discussed.

The initial versions of the questionnaire began with the presentation of the twelve domains identified by Binns-Calvey (i.e., access to care, competing responsibilities, social support, financial situation, environment, resources, skills abilities and knowledge, emotional state, cultural perspectives/spiritual beliefs, attitudes toward illness, attitudes toward healthcare providers and the system and health behaviors) and by providing examples of the types of factors that might be included under each theme. However, pilot participants reported that this did influence their answers. As a result, the final questionnaire consisted of a single broad open-ended question that invited respondents to describe up to three different situations during which they had personalized care in the past: "Describe a situation where you adapted treatment because of patient's specificities: you did differently that what you would do for the majority of the patients" [19]. For each clinical situation, participants were prompted to elaborate on the patient's characteristics (e.g., disease, age), the type of situation (e.g., prescription of a given treatment), the personalization, the patient's characteristics and/or circumstances considered for personalization, and the objective of the personalization. In addition, participants answered six questions collecting sociodemographic and professional information (Additional file 2: Supplementary Method 3).

#### Data collection

We embedded the final questionnaire on a dedicated website that presented the purpose of the study, the investigators, the time required to complete the questionnaire, and a link to the full study protocol. We used the Platform for Research Online and CitizEn Science Surveys (PROCESS), a secured platform hosted by Université Paris Cité that is available on computers, smartphones, and tablets [20]. There was no time limit for completing the questionnaire. The survey was open to every visitor, but we used cookies to prevent multiple

completions of the questionnaire. Once submitted, participants could no longer modify the questionnaire.

#### Data analysis

We excluded answers from ineligible participants from the analysis. We analyzed all other questionnaires. We included two situations from the pilot test because this test involved the final questionnaire. We computed the number and frequencies for categorical variables and medians and interquartile ranges (IQR) for continuous variables.

We analyzed answers to the open-ended questions via manual content analysis [21, 22]. First, answers considered out-of-scope (e.g., adaptation based on standard recommendations and personalization based on non-patient factors (e.g., a physician's end-of-day fatigue)) were discussed by two investigators (PD and VTT) and excluded from the analysis. Second, for coding in-scope answers, one investigator (PD) identified "in vivo codes" (i.e., words used by participants to describe how they personalized care) related to our three objectives: (1) what was personalized (e.g., treatment prescription); (2) why (e.g., to improve compliance); and (3) which psychosocial and contextual markers were considered by physicians to personalize their care (e.g., patient age and intellectual capacity) (Additional file 3: Supplementary Method 4). During iterative meetings, PD, VTT, KK and PR discussed the codes, subthemes, and themes based on their experiences and existing classifications of contextual factors identified in the literature [12, 23]. During this step, the investigators separated elements of clinical judgment (i.e., clinicians deciding that a patient was too frail for a recommended treatment) and the consideration of patient values (a patient does not want to travel for weekly therapy). We further categorized themes into two domains to organize the results: patients' psychosocial factors and circumstances, inspired by the classification of contextual factors developed by Binns-Calvey et al. [12].

The objective of our study was to identify a comprehensive list of psychosocial and contextual markers that could be used to personalize care. Data saturation represents the point in data collection and analysis when new information produces little or no change to the codebook, the codebook representing the collection of codes that link expressions found in the text to all abstract constructs identified by the researchers [24]. To determine the point of data saturation in our study, we used a mathematical model to predict the potential number of new markers that could be identified by adding new participants to the study [25]. This model involved (1) drawing the 'observed' accumulation curve of identified markers during the course of the study,

(2) predicting the theoretical number of markers that could be found with the inclusion of more respondents, and (3) estimating the local slope of the expected accumulation curve of markers (i.e., the number of respondents to be included to identify a new marker). Thus, the model did not provide information on the nature of the identified markers but rather on the probability of finding new markers by recruiting new participants.

We triangulated manual content analysis with AI-assisted textual analysis using Generative Pre-Trained Transformer (GPT) 3.5-Turbo, a large language model developed by OpenAI [26]. Previous research has shown that GPT 3.5-Turbo can infer at least partially some of the findings from manual content analysis [27]. In short, each open-ended answer was presented to the model within a prompt asking to identify the patients' psychosocial and contextual markers used to personalize care. Prompts were iteratively developed on 2.0% of the open-ended data. The model used a temperature parameter of 0, ensuring determinist answers and no variation in answers from the model. One investigator (PD) assessed, in the remaining 98.0% of the answers, whether the themes identified during manual analysis had been retrieved (or not) in the AI-assisted textual analysis.

All the statistical analyses were performed with the R statistical package version 4.3 (The R Foundation for Statistical Computing, [www.R-project.org/](http://www.R-project.org/)).

## Results

### Participant characteristics

Between March 31, 2023, and August 10, 2023, 1340 individuals opened the online questionnaire, 1004 (75.0%) of whom were eligible physicians (227 people did not answer to the eligibility questions, 94 were residents, 14 did not see patients, and one was a pharmacist; see Additional file 4: Fig. S1). The participants' median age was 39 years (IQR 34 to 50), with 607 (60.5%) identified as women (Table 1). The median time elapsed since the defense of the participants' medical theses was 11 years (IQR 5.5 to 22). In total, 673 (67.0%) physicians worked in outpatient settings, and 238 (23.7%) worked in inpatient settings. General practice was the most represented medical specialty ( $n=655$ , 65.2%). We compared the characteristics of physicians in our sample with national data describing all physicians in France and found that our sample included younger participants, more often females, more general practitioners, and more physicians working in outpatient settings (Additional file 4: Table S1) [28].

### Clinical situations where physicians personalize the care of a given patient

A total of 227 (22.6%) participants described at least one clinical situation during which they provided personalized care for a patient. The reasons for excluding some open-ended answers from the analyses are available in

**Table 1** Characteristics of participants

Characteristics	Total (n = 1004)	Physicians who reported situations during which they personalized care (n = 227)	Physicians who did not report situations during which they personalized care (n = 777)
<b>Age (years), median (IQR)</b>	39 (34-50)	40 (34-53)	38 (34-50)
<b>Female gender, n (%)</b>	607 (60.5%)	137 (60.4%)	470 (60.5%)
<b>Time since thesis defense (years), median (IQR)</b>	11 (5.5-22)	12.5 (6-25)	11 (5-22)
<b>Place of medical practice, n (%)</b>			
Outpatient setting	673 (67.0%)	135 (59.5%)	538 (69.2%)
Inpatient setting	238 (23.7%)	68 (30.0%)	170 (21.9%)
Mixed	79 (7.9%)	21 (9.3%)	58 (7.5%)
Other	9 (0.9%)	1 (0.4%)	8 (1.0%)
Missing	4 (0.4%)	2 (0.9%)	3 (0.4%)
<b>Specialties, n (%)</b>			
General practitioners	655 (65.2%)	132 (58.1%)	523 (67.3%)
Pediatricians	60 (6.0%)	16 (7.0%)	44 (5.7%)
Obstetricians/gynecologists	19 (1.9%)	3 (1.3%)	16 (2.1%)
Geriatricians	12 (1.2%)	3 (1.3%)	9 (1.2%)
Emergency specialists	22 (2.2%)	8 (3.5%)	14 (1.8%)
Other medical specialists	192 (19.1%)	57 (22.2%)	135 (17.8%)
Surgeons	44 (4.4%)	8 (3.5%)	36 (4.6%)

Additional file 4: Table S2. Relevant in-scope descriptions represented 317 clinical situations and a corpus of 22,223 words.

Approximately half of the clinical situations (53.3%) for which patient sex was reported included male patients. The reported median age of the patients was 60.5 years (IQR 38.5 to 75.0). The reported diseases ranged from cardiovascular diseases ( $n=44$ , 16.4%) to psychiatric diseases ( $n=28$ , 10.5%) and respiratory diseases ( $n=27$ , 10.1%).

### Elements of personalized care and objectives of personalization

Physicians personalized three elements during encounters: (1) treatment prescription (84.9%) (e.g., adaptation of the intervention, modification of the initiation time [for example, delaying the start of the intervention]), (2) strategies for diagnosis and follow-up (8.9%) (e.g., modification of the tests ordered or of the frequency of follow-up), and (3) the conduct of the encounter (5.8%) (e.g., adaptation of verbal or nonverbal communication) (Table 2). For example, a 35-year-old medical specialist described how she adapted the frequency of exams to her patients' preferences. "I saw a patient, Ms. G, aged 50 [...] for a brain metastasis melanoma. [...] In theory, a morphological assessment by CT or MRI is recommended every 3 months. Ms. G [...] distrusts the medical profession and refuses many treatments/protocols despite her relatively young age [...] we spaced out the morphological check-ups every 4 months and then every 6 months (instead of every 3 months). Today, Mrs. G no longer has any morphological check-ups [...]"

Personalization aimed to (1) improve patients' engagement in care (76.1%), (2) avoid adverse events (13.9%), (3) adapt care because standard care could not be performed (4.5%), (4) improve intrinsic care effectiveness (2.9%), or (5) make physicians more comfortable with their decisions (2.6%) (Table 3). For example, a 30-year-old medical specialist explained how he did not opt for intravenous treatment in a day hospital to not overburden his patient. "I saw Mr. X, aged 55, who had a poor prognosis kidney cancer that was progressing after a first line of oral treatment. I should have offered him intravenous immunotherapy. Because the patient lived far from the hospital, we opted for a new line of oral treatment so that he wouldn't have to come often to the hospital."

### Psychosocial and contextual markers considered by physicians to personalize care

We identified 40 psychosocial and contextual markers considered by physicians when personalizing care (Table 4); 27 were related to patients' psychosocial factors, and 13 were related to circumstances.

Patients' psychosocial factors included (1) intentions and preferences (12.9% of characteristics used to personalize care), (2) capacities (9.6%), (3) experiences of disease and care accumulated by patients themselves or by their parents (6.2%), (4) beliefs (7.0%), (5) awareness of the disease and treatment (5.8%), (6) psychological state (5.5%), and (8) current health behavior (2.4%) (Table 2). For example, a 39-year-old general practitioner reported that because of the patient's perspective of treatment, he chose to not prescribe an antidepressant. "I saw Mr. V in consultation, who presented with a depressive syndrome [...]. In theory, I should have introduced an antidepressant, but the patient refused treatment for fear of side effects because he had seen his ex-wife [...] abusing them and being drowsy [...]"

Circumstances involved (1) competing activities and responsibilities (13.7%), (2) access to care (4.6%), (3) support from informal caregivers (3.4%), and (4) living environment (2.2%). For example, a 35-year-old general practitioner reported that she adapted her care attitude because "I saw Mr. & Mrs. G in consultation, who had always been treated with homeopathy by their previous GP who had retired. They asked me to renew their usual prescription. I do not usually prescribe homeopathy. [...]. However, I did what they asked [...] because I do not think it is easy to change their GP, and the therapeutic alliance is essential"

In addition to these factors, physicians personalized care based on health markers, representing approximately 18% of the elements used to personalize care (Additional file 5: Table S3).

The data saturation models showed that at least 97.0% of the potential markers were identified. The model suggested that collecting and analyzing 300 additional situations would only have identified one additional marker (Additional file 6: Fig. S2).

### Triangulation of the manual content analysis with AI-assisted textual analysis

We used the GPT 3.5-Turbo model with a prompt aimed at instructing the model to mimic the manual content analysis. We developed the prompt during iterative testing on 5 clinical situations (Additional file 7: Supplementary Method 5). When comparing the sub-themes identified during manual analysis (i.e., summarization of the "in vivo codes" from patients) with the output of the AI-assisted textual analysis, AI-assisted analysis identified markers like those identified by the human investigator in 285 (89.9%) clinical situations. Examples are available in Additional file 7: Table S4.

**Table 2** Elements of care personalized

Themes	Subthemes	Definition	N = 225 (%)
<b>Personalization of treatment prescription</b>	Adaptation of the recommended intervention	Modification of the time, frequency, posology, form/galenic, choice/addition of another treatment	90 (40.0%) 191 (84.9%)
	Modification of initiation time	Modification of the time when the treatment is started (e.g., delayed start after the resolution of specific life circumstances)	33 (14.7%)
	Nonprescription of the recommended intervention and/or prescription of a nonrecommended intervention	The recommended intervention is not prescribed An alternative, not mentioned in guidelines for this specific situation can be chosen instead (e.g., choosing a third line treatment as first line)	68 (30.2%)
<b>Personalization of diagnostic and follow-up</b>	Adaptation of follow-up modalities	Change in the personnel involved (e.g., nurse practitioner vs. physician), the location of the encounter, the scheduling or the use of teleconsultation options	9 (4.0%) 20 (8.9%)
	Modification of the time or frequency of diagnostic tests/follow-up	Modification of the timing, frequency, or of diagnostic tests, follow-up exams, or medical appointments	5 (2.2%)
	Nonprescription of the recommended exam/follow-up and/or prescription of a nonrecommended exam/follow-up	The recommended exam/follow-up is not prescribed An alternative can be chosen instead	6 (2.7%)
<b>Personalization of the conduct of the encounter</b>	Adaptation of verbal communication	The strategic use and modification of verbal language. This includes simplifying medical jargon, using metaphors or analogies, repeating key points, or employing persuasive language techniques	7 (3.1%) 13 (5.8%)
	Adaptation of nonverbal communication	Modification of nonverbal cues, including body language, facial expressions, gestures, physical distance, or even indirect communication methods such as the use of visual aids or demonstrations	5 (2.2%)
	Change in the persons involved in care	Change of individuals present during the encounter (e.g., partner)	1 (0.4%)

**Table 3** Objectives of care personalization

Themes	Subthemes	Definition	N = 309 (%)	
<b>To improve patients' engagement in care</b>	To improve adherence to care	Enhancement of patient's adherence to the physician's prescription	104 (33.7%)	235 (76.1%)
	To prioritize quality of life or preferences over the burden of treatment	Care adaptation to respect patient's preferences or maximize their quality of life and decrease impact of care or disease on functioning	64 (20.7%)	
	To reassure patients	Restoration of the confidence or relieving doubts and fears of patients	38 (12.3%)	
	To preserve or improve the doctor-patient relationship	Mutual respect, understanding, and confidence between patients and their care provider	19 (6.1%)	
	To reassure relatives	Restoration of the confidence or relieving doubts and fears of patients' partner or family	10 (3.2%)	
<b>To avoid adverse events</b>	Treatment-related adverse events	Prevention of unwanted or harmful reactions linked to a drug or treatment	28 (9.1%)	43 (13.9%)
	Disease complications	Prevention of the deterioration in health status linked to pathophysiologic response to a disease	15 (4.9%)	
<b>Because standard care could not be performed</b>		Situations where standard or guideline-based treatments are not feasible	14 (4.5%)	
<b>To improve intrinsic care effectiveness</b>	Pharmacodynamic/pharmacokinetic optimization	Enhancement of the pharmacologic effect of the treatment	5 (1.6%)	9 (2.9%)
	Leveraging on the placebo effect	Psychophysiological phenomenon where a patient experiences an improvement in condition due to their perception of receiving treatment	4 (1.3%)	
<b>To make physicians more comfortable with their decisions</b>		Restoring confidence or relieving doubts and fears of the physician about patients' care	8 (2.6%)	

## Discussion

### Main findings

Physicians personalize care during treatment prescription, diagnosis or follow-up modalities, or consultation to enhance treatment engagement, respect patients' priorities and preferences or reinforce patient-physician relationships by using 40 markers reflecting patients' psychosocial and contextual factors. To our knowledge, this is the first list of fine-grained individuals' psychological, social, cultural, behavioral, and economic factors that may influence their response to treatment across a broad range of situations and diseases. This list will serve as the basis for identifying and/or developing instruments to assess these markers to evaluate their impact on treatment effects in clinical trials or observational studies.

The markers we identified align with the literature on contextual elements that physicians should consider to avoid medical errors, to deliver patient- and family-centered care, and to those considered in self- and family-management theory [12–17]. Specifically, Weiner et al. showed that failing to account for patients' characteristics (e.g., skills, abilities and knowledge, emotional

state) and circumstances (e.g., access to care, competing responsibility) during medical encounters could lead to detrimental contextual errors in care [29]. However, our study goes beyond the broad themes already identified in the literature by offering a detailed taxonomy of markers to consider, objectives and instances of personalizing care and by identifying additional markers, such as specific elements of patients' support networks (e.g., geographical and emotional proximity of informal caregivers). Moreover, our study involved a larger sample of participants who described a broad spectrum of clinical situations.

### Strengths and limitations

This study has several strengths. We used an online questionnaire with open-ended questions to recruit a large and diverse sample of physicians in terms of experience, specialty, and place of practice. While the online questionnaire prevented in-depth probing of specific information and follow-up elaborations, it represented a trade-off between the number and diversity of respondents and the richness of individual answers. Second, we used a

**Table 4** Psychosocial and contextual markers (n = 40) used by physicians to personalize care

Themes	Subthemes	Definition	N = 417 (%)
<b>Psychosocial markers (n = 27)</b>	<b>Intentions and preferences</b>	Wishes, refusals and priorities of the patient, and the magnitude of these preferences	52 (12.5%) 54 (12.9%)
	<b>Transparency</b>	Patients' commitment to following the care provider's recommendations, indicating their intentions and motivation to comply with the prescribed treatment plan	2 (0.5%)
<b>Capacities</b>	<b>Physical limits to treatment adherence</b>	Practicality and capability of patients adhering to a treatment regimen, considering factors related to administration methods (eg, size of medication)	11 (2.6%) 40 (9.6%)
	<b>Education level</b>	Extent of formal education completed by the patient, influencing their overall health management	2 (0.5%)
	<b>Intellectual capacity</b>	Cognitive abilities, ranging from patients with intellectual deficiencies to those capable of understanding complex concepts and medical information	7 (1.7%)
	<b>Languages spoken and/or understood</b>	Languages spoken or comprehended by patients	7 (1.7%)
	<b>Literacy/Numeracy</b>	Patients' ability or inability to read, write, and count	2 (0.5%)
	<b>Mental load related to illness management</b>	Cognitive and emotional burden due to the constant attention, decision-making, and emotional energy required to manage their health condition	4 (1%)
	<b>Mental availability during the consultation</b>	Patients' ability to assimilate increasing amounts of information during the encounter	4 (1%)
<b>Experiences of disease and care</b>	<b>Self-management</b>	Patients' ability and self-confidence to manage their health conditions, including medication adherence, lifestyle modifications, and symptom recognition	2 (0.5%)
	<b>Motivation for behavior change</b>	Patients' willingness and drive to adopt and sustain health-promoting behaviors or make necessary changes to their lifestyle	1 (0.2%)
	<b>Past personal experience</b>	History of the patient's encounters with illness and treatment, including past complications of a disease, and previous experiences of side effects from treatment	27 (6.5%) 36 (8.6%)
<b>Past adherence to care recommendations</b>	<b>Past experience within social network</b>	Input gained from patients' social network—encompassing family, friends, neighbors, and acquaintances—about their experience with disease and treatment	9 (2.2%)
	<b>Past adherence to care recommendations</b>	Physicians' perception of how patients adhered to the healthcare provider's recommendations in the past	12 (2.9%) 26 (6.2%)



**Table 4** (continued)

Themes	Subthemes	Definition	N = 417 (%)
<b>Beliefs</b>	<b>Quality of the relation between patients and their care providers</b>	Nature and dynamics of patient-physicians interaction, trust, and communication between the patient and their healthcare provider	14 (3.4%)
	<b>Cultural beliefs</b>	Shared convictions within a specific cultural group, shaping their understanding of diseases, their causes, symptoms and treatments	19 (4.6%)
	<b>Spiritual beliefs</b>	Religious or mystical convictions that can influence patients' preferences and acceptance of care choices	10 (2.4%)
	<b>Acceptance</b>	Degree to which patients recognize and embrace their disease (contrary to denial), their necessary examinations and the corresponding treatment plan	14 (3.4%)
	<b>Fear of loss</b>	Patients' attachment to certain aspects of their identity or abilities that they fear losing due to their disease or treatment	4 (1%)
	<b>Knowledge</b>	Patients' level of information and understanding about their disease, treatment, and self-management strategies	5 (1.2%)
	<b>Insight</b>	Patients' self-awareness about their disease, the need for treatment, and the implications of their symptoms on personal and social functioning	1 (0.2%)
	<b>Health-related anxiety</b>	Extent of worry related to patients' health condition, including fears about disease progression, treatment outcomes, complications or consequences on daily life	18 (4.3%)
	<b>Mood</b>	Prevailing emotional state of patients, including feelings of happiness, sadness, or anxiety	5 (1.2%)
	<b>Diet</b>	Dietary pattern, including the types of food consumed, portion sizes, adherence to specific nutritional recommendations and food traditions	3 (0.7%)
<b>Current health behavior</b>	<b>Healthcare seeking behavior</b>	Patients' tendencies when seeking healthcare services, including their timeliness, frequency, and preferences for specific healthcare providers or settings	4 (1%)
	<b>Physical activity</b>	Level of physical activity (professional or leisure) undertaken by the patient, including frequency, intensity, and type of activities engaged in	2 (0.5%)
<b>Use of illicit drugs</b>	<b>Use of illicit drugs</b>	Consumption of illicit drugs by the patient, including type, route of administration, frequency of consumption	1 (0.2%)

**Table 4** (continued)

Contextual markers (n = 13)	Themes	Subthemes	Definition	N = 417 (%)
		<b>Competing activities and responsibilities</b>		
		<b>Family life</b>	Patients' family-related responsibilities, including childcare, caregiving duties, and other familial commitments	15 (3.6%)
		<b>Professional life</b>	Patients' work-related commitments, including work schedule, workload, and workplace health-related policies	22 (5.3%)
		<b>Religious life</b>	Involvement in religious or spiritual practices, ceremonies, or obligations	7 (1.7%)
		<b>Social or leisure activities</b>	Engagement in social or recreational pursuits	13 (3.1%)
		<b>Ability to afford care</b>	Capacity to bear the financial costs associated with health services, encompassing health insurance coverage or out-of-pocket expenses	10 (2.4%)
		<b>Geographical proximity to care</b>	Physical distance to healthcare facilities, taking into consideration potential challenges related to access (e.g., medical desert, poor transport links)	5 (1.2%)
		<b>Supply side factors</b>	Access to specific healthcare providers, medications, diagnostic test, including availability, resource allocation, wait times for appointments	4 (1%)
		<b>Emotional proximity</b>	Closeness and emotional bond between patients and their informal caregivers, which can impact the availability of emotional support or encouragement	2 (0.5%)
		<b>Support from informal caregivers</b>		14 (3.4%)
		<b>Geographical proximity</b>	Physical distance between patients and informal caregivers, such as family members or friends	3 (0.7%)
		<b>Knowledge of the disease</b>	Understanding and awareness of patients' health conditions by their informal caregivers	2 (0.5%)
		<b>Social support density</b>	Degree of social isolation, lack of social support or loneliness experienced by patients	7 (1.7%)
<b>Living environment</b>	<b>Environment adapted to the patient</b>	Degree to which the infrastructure and facilities are adapted to patients' specific needs and limitations related to their health condition	2 (0.5%)	
	<b>Stable/adequate housing</b>	Presence of secure, reliable, and suitable housing conditions	8 (1.9%)	

mathematical model to predict the number of new markers that could be identified by adding new participants to the study and rigorously demonstrated data saturation, strengthening the credibility of our results, even if more than three-quarters of the participants did not report any clinical situation in the open-ended prompts. Third, we triangulated our manual content analysis with an AI-assisted textual analysis using generative AI models (namely, the GPT-3.5-Turbo model also used in ChatGPT). This is one of the first studies that uses and appraises the use of generative AI models to triangulate the analysis of open-ended data. The high agreement between the manual analysis and GPT may suggest that such tools could increase the efficiency of research by augmenting human investigators and/or cost-effectiveness by limiting the duplication of human analysis [30, 31].

This study has several limitations. First, our data are self-reported and only reflect what physicians understood, what they remembered, or what they were willing to disclose. This means that interpretation of the number of times a specific theme was elicited should be made with caution: frequently elicited themes may be more “evident” or easier to recall for physicians within our sample. For example, adaptation of care based on patients’ “professional life” (e.g., nightshifts) is one of the more elicited themes and was described as easy to recall during pilot testing. Notably, our study was exploratory and was not designed to identify which markers were the most frequently used. Second, the transferability of our findings is limited by the fact that we recruited a diverse sample of French physicians. In comparison to French physicians, our sample was younger (72.6% were under 50 in our sample and 47.9% in France) and included a greater share of GPs (65.2% in our sample and 43.2% in France) [28]. Third, the AI-assisted textual analysis captured more coding categories than the manual analysis because of the difference in granularity between human and machine analysis. However, the “content” of the analysis was similar.

### Implications for practice

Our study supports the fact that care must be personalized for each individual patient, based on their psychosocial and contextual characteristics [32–34]. For example, a study evaluating 614 deviations from guidelines to adapt care to patients’ circumstances showed that 93.6% were medically appropriate according to a peer-review panel [32]. Physicians need to be constantly aware of when and how they can adapt care to their patients’ individual circumstances. Some of the markers identified are not classically taught in medical school, such as accounting for patients’ or their entourage’s past experiences of disease and care. We believe that care personalization cannot be fully taught during lessons but must be learned

by students at the bedside of real (as opposed to simulated) patients.

### Implications for policy

There is a discordance between clinical practice guidelines describing recommended care based on evidence at the population level for the “average patient” and care for the individual patient at hand [35–37]. Our study calls for the development of standardized personalization for frequent clinical situations encountered by physicians. This would allow us to move from evidence of the effect of interventions in broad populations, from a one-size-fits-all perspective, to evidence in thinner and more granular population strata, approaching individualized patient care. The development of standardized personalization will facilitate the analysis of care quality by using concordance with recommended care and avoiding inadequate reward or penalization of physicians through performance payment policies that do not account for patients’ circumstances [38, 39]. Finally, the definition of personalization factors and their measurement will allow us to quantify how often these factors suggest different treatments related to common guidelines.

### Implications for research

This study identified which potential psychosocial and contextual markers can be used to tailor whether and how an intervention is delivered to a patient, to which this study contributes. The next steps will require identifying or developing instruments to assess these markers, from patient-reported outcome measures (PROMs) and cognitive tests to surrogate markers of behavior captured by wearable devices. Finally, testing of these markers in clinical trials or observational studies contributes to the heterogeneity of treatment effect (HTE) [40]. Detecting a contrast in relative treatment effects between subgroups may require a substantial sample size, which may be addressed by pragmatic or clinically integrated trials or large meta-analyses of RCTs or observational studies at the individual-patient level.

### Conclusions

In this study, we identified 40 psychosocial and contextual markers used by physicians to personalize care to patients’ contexts and lives. Rigorous measurement of these markers and evaluation of their effect as treatment modifiers will enable us to move from experience-based personalization of care to patient contexts to evidence-based personalization.

### Abbreviations

NHS	National Health Service
CHERRIES	Checklist for Reporting Results of Internet E-Surveys
PROCESS	Platform for Research Online and CitizEn Science Surveys

IQR	Interquartile ranges
GPT	Generative Pre-Trained Transformer
PROMs	Patient-reported outcome measures
HTE	Heterogeneity of treatment effect

## Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12916-024-03616-4>.

Additional file 1: Table S1. Reported elements from CHERRIES checklist.

Additional file 2: Supplementary Method 1. Hospitals, universities, and partner physicians' organizations involved in recruitment. Supplementary Method 2. Example of communication material (in French). Supplementary Method 3. Online questionnaire.

Additional file 3: Supplementary Method 4. Example of manual content analysis.

Additional file 4: Fig. S1. Study flow chart. Table S1. Comparison of the characteristics of participants in the study and French physicians. Table S2. Number and reasons for exclusion of participants who answered to open-ended questions.

Additional file 5: Table S3. Health markers (n=9) considered by physicians to personalize care.

Additional file 6: Fig. S2. Assessment of the point of data saturation for the 49 markers.

Additional file 7: Supplementary Method 5. Final prompt used for AI-assisted content analysis. Table S4. Examples of comparisons between subthemes identified by AI and by manual analysis.

### Acknowledgements

Not applicable.

### Authors' contributions

PD, PR and VTT conceived and designed the study. PD, AM and VTT participated in the data acquisition. PD and VTT participated in the data analysis. PD, KRK and VTT participated in the interpretation of data. PD, KRK, PR and VTT drafted the manuscript or substantively revised it. All authors agree with the manuscript results and conclusions, read and met ICMJE criteria for authorship. PD and V-TT are the guarantors, had full access to the data in the study, and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors read and approved the final manuscript.

### Authors' information

Not applicable.

### Authors' Twitter handles

Twitter handles: @PaulDomenach (PD), @KrauseKarolin (KRK), @AMalmartel (AM), @tritrans3 (VTT).

### Funding

The study was realized in the context of the @Hotel-Dieu project, which was funded by the Banque Publique d'Investissement in France. Paul Domenach was supported by an academic grant from the program "Année de recherche", Lyon 1 University—Hospices Civils de Lyon—ARS AURA, Lyon, France. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

### Availability of data and materials

The original data, the data extracted and data extraction grids are available from the corresponding author upon reasonable request.

### Declarations

#### Ethics approval and consent to participate

Not applicable.

### Consent for publication

Not applicable.

### Competing interests

The authors declare no competing interests.

### Author details

<sup>1</sup>Université Paris Cité and Université Sorbonne Paris Nord, Inserm, INRAE, Centre for Research in Epidemiology and Statistics (CRESS), Paris 75004, France. <sup>2</sup>Department of General Medicine, Claude Bernard Lyon 1 University, Lyon 69003, France. <sup>3</sup>Department of General Medicine, Paris Cité University, Paris 75004, France. <sup>4</sup>Center for Clinical Epidemiology, Hôtel-Dieu Hospital, Assistance Publique Hôpitaux de Paris, Paris, France. <sup>5</sup>Department of Epidemiology, Mailman School of Public Health, Columbia University, New York City, NY, USA.

Received: 29 July 2024 Accepted: 4 September 2024

Published online: 27 September 2024

### References

1. Woolf SH. Practice guidelines: a new reality in medicine: III. Impact on patient care. *Arch Intern Med*. 1993;153:2646–55.
2. Sackett DL, Rosenberg WMC, Gray JAM, Haynes RB, Richardson WS. Evidence based medicine: what it is and what it isn't. *BMJ*. 1996;312:71–2.
3. Haynes RB, Devereaux PJ, Guyatt GH. Clinical expertise in the era of evidence-based medicine and patient choice. *BMJ Evid Based Med*. 2002;7:36–8.
4. NHS England » Universal Personalised Care: Implementing the Comprehensive Model. <https://www.england.nhs.uk/publication/universal-personalised-care-implementing-the-comprehensive-model/>. Accessed 19 July 2023.
5. Ziegelstein RC. Personomics. *JAMA Intern Med*. 2015;175:888–9.
6. Kock L, Brown J, Hiscock R, Tattan-Birch H, Smith C, Shahab L. Individual-level behavioural smoking cessation interventions tailored for disadvantaged socioeconomic position: a systematic review and meta-regression. *Lancet Public Health*. 2019;4:e628–44.
7. Eysenbach G. Improving the quality of web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). *J Med Internet Res*. 2004;6:e132.
8. Faugier J, Sargeant M. Sampling hard to reach populations. *J Adv Nurs*. 1997;26:790–7.
9. Denscombe M. *The good research guide: Research methods for small-scale social research projects*. Maidenhead, England: McGraw-Hill/Open University Press; 2014.
10. Arrêté du 12 avril 2018 fixant la liste des recherches mentionnées au 3° de l'article L. 1121-1 du code de la santé publique. <https://www.legifrance.gouv.fr/loda/id/JORFTEXT000036805820>. Accessed 27 Oct 2023.
11. Malmartel A, Ravaud P, Tran V-T. A methodological framework allows the identification of personomic markers to consider when designing personalized interventions. *J Clin Epidemiol*. 2023;159:235–45.
12. Binns-Calvey AE, Malhiot A, Kostovich CT, Lavelle SL, Stroupe K, Gerber BS, et al. Validating domains of patient contextual factors essential to preventing contextual errors: a qualitative study conducted at Chicago area veterans health administration sites. *Acad Med*. 2017;92:1287–93.
13. Horwitz RJ, Lobitz G, Mawn M, Conroy AH, Cullen MR, Sim I, et al. Biosocial medicine: Biology, biography, and the tailored care of the patient. *SSM Popul Health*. 2021;15:100863.
14. Tinetti ME, Costello DM, Naik AD, Davenport C, Hernandez-Bigos K, Van Liew JR, et al. Outcome goals and health care preferences of older adults with multiple chronic conditions. *JAMA Netw Open*. 2021;4:e211271.
15. Rolnick SJ, Pawloski PA, Hedblom BD, Asche SE, Bruzek RJ. Patient characteristics associated with medication adherence. *Clin Med Res*. 2013;11:54–65.
16. Bos-Touwen ID, Trappenburg JCA, Van Der Wulp I, Schuurmans MJ, De Wit NJ. Patient factors that influence clinicians' decision making in self-management support: a clinical vignette study. *PLoS One*. 2017;12:e0171251.
17. Schneider-Kamp A, Nielsen HL, Sodemann M. Patientology revisited: toward tailored care pathways. *J Eval Clin Pract*. 2023;29:472–84.

18. Guyatt GH, Bombardier C, Tugwell P. Measuring disease-specific quality of life in clinical trials. *CMAJ*. 1986;134(8):889–95.
19. Jansen H. The Logic of Qualitative Survey Research and its Position in the Field of Social Research Methods. *Forum Qual Soc Res*. 2010;11.
20. PROCESS (Platform for Research Online and Citizen Science Surveys) du CRESS Plateformes. <https://plateformes.u-paris.fr/process-platform-for-research-online-and-citizen-science-surveys-du-cress/>. Accessed 22 April 2024.
21. Krippendorff K. Content analysis: an introduction to its methodology. 2nd ed. Thousand Oaks, Calif.: Sage Publ; 1980.
22. Stemler S. An overview of content analysis. *Pract Assess Res Eval*. 2000;7(1):17.
23. Nielsen SM, Uggen Rasmussen M, Boers M, Van Der Windt DA, De Wit M, Woodworth TG, et al. Towards consensus in defining and handling contextual factors within rheumatology trials: an initial qualitative study from an OMERACT working group. *Ann Rheum Dis*. 2021;80:242–9.
24. Guest G, Bunce A, Johnson L. How many interviews are enough?: An experiment with data saturation and variability. *Field Methods*. 2006;18:59–82.
25. Tran V-T, Porcher R, Tran V-C, Ravaud P. Predicting data saturation in qualitative surveys with mathematical models from ecological research. *J Clin Epidemiol*. 2017;82:71–78.e2.
26. OpenAI Platform. <https://platform.openai.com/docs/models/gpt-3-5-turbo>. Accessed 25 April 2023.
27. Renz SM, Carrington JM, Badger TA. Two strategies for qualitative content analysis: an intramethod approach to triangulation. *Qual Health Res*. 2018;28:824–31.
28. Démographie des professionnels de santé - DREES. <https://drees.shinyapps.io/demographie-ps/>. Accessed 28 Sept 2023.
29. Weiner SJ, Schwartz A, Weaver F, Goldberg J, Yudkowsky R, Sharma G, et al. Contextual errors and failures in individualizing patient care: a multicenter study. *Ann Intern Med*. 2010;153:69–75.
30. Loh E. ChatGPT and generative AI chatbots: challenges and opportunities for science, medicine and medical leaders. *BMJ Leader*. 2023:leader–2023–000797.
31. Morley J, DeVito NJ, Zhang J. Generative AI for medical research. *BMJ*. 2023;382:1551.
32. Persell SD, Dolan NC, Friesema EM, Thompson JA, Kaiser D, Baker DW. Frequency of inappropriate medical exceptions to quality measures. *Ann Intern Med*. 2010;152:225–31.
33. Litzelman DK, Tierney WM. Physicians' reasons for failing to comply with computerized preventive care guidelines. *J Gen Intern Med*. 1996;11:497–9.
34. Brown T, Zelch B, Lee JY, Doctor JN, Linder JA, Sullivan MD, et al. A qualitative description of clinician free-text rationales entered within accountable justification interventions. *Appl Clin Inform*. 2022;13:820–7.
35. Rothwell PM. Can overall results of clinical trials be applied to all patients? *Lancet*. 1995;345:1616–9.
36. Kent DM, Hayward RA. Limitations of applying summary results of clinical trials to individual patients: the need for risk stratification. *JAMA*. 2007;298:1209–12.
37. Horwitz RJ, Charlson ME, Singer BH. Medicine based evidence and personalized care of patients. *Eur J Clin Invest*. 2018;48:e12945.
38. Flodgren G, Eccles MP, Shepperd S, Scott A, Parmelli E, Beyer FR. An overview of reviews evaluating the effectiveness of financial incentives in changing healthcare professional behaviours and patient outcomes. *Cochrane Database Syst Rev*. 2011;2011:CD009255.
39. Khan N, Rudoler D, McDiarmid M, Peckham S. A pay for performance scheme in primary care: meta-synthesis of qualitative studies on the provider experiences of the quality and outcomes framework in the UK. *BMC Fam Pract*. 2020;21:142.
40. Kent DM, Van Klaveren D, Paulus JK, D'Agostino R, Goodman S, Hayward R, et al. The Predictive Approaches to Treatment effect Heterogeneity (PATH) statement: explanation and elaboration. *Ann Intern Med*. 2020;172:W1–25.

## Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.