

Perceived Versus Actual Understanding of Combination Therapies and Biomarker-Driven Treatment: A Pan-European Survey of 1,446 Cancer Patients

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treasurer of the Federación Española de Cáncer de Mama (FECMA). She also participates in patient advisory activities with EORTC, the European Medicines Agency (EMA) and BIG (Breast International Group). She takes part in patient advisory boards with the following pharma companies: Steamline Menarini, Pfizer, Novartis and Be One. FECMA receives financial support from the companies mentioned, as well as from Astra Zeneca and Lilly. Her roles are voluntary and unrelated to the preparation of this manuscript. This study received unconditional financial support from Astellas. Cancer Patients Europe (CPE) retained full editorial control over study design, data collection, analysis, interpretation, and publication. The authors have no other competing financial or personal interests to declare.

Abstract

Purpose: Combination therapies (CTs) and biomarker-guided treatment selection are increasingly central to oncology, yet how closely patients' perceived understanding matches their actual understanding is unknown. We examined whether patients recognise this gap, how benefit versus harm literacy compares, and how far both vary by country.

Methods: A 29-item anonymous survey in five languages ran for 90 days via Cancer Patients Europe networks. Individual responses were analysed, allowing items to be cross-tabulated within respondents. Proportions carry Wilson 95% CIs; the paired benefit–harm comparison uses McNemar's test; country differences use χ^2 with Holm adjustment and multivariable logistic regression.

Results: Of 1,446 respondents, 70.4% (n = 1,103) felt adequately informed, yet 45.9% (n = 985) had never been told about a combination approach and 39.8% (n = 937) did not know whether biomarker testing guided care; linking responses within respondents, 25.8% (95% CI 23.2–28.6) both felt adequately informed and had never been told — adequacy misclassifies about one patient in four. Patients were over three times as likely to name a benefit but no harm than the reverse (195 vs 55 discordant pairs; McNemar $P < .001$). Country differences persisted after adjustment (Italy adjusted OR 2.09, 1.34–3.26; Germany 1.62, 1.07–2.45; reference United Kingdom).

Conclusion: Patient-reported information adequacy misclassifies about a quarter of patients, communication favours benefits over harms within individuals, and country differences survive adjustment — locating the deficit in how systems communicate. Practice should replace satisfaction-based metrics with comprehension checks, adopt toxicity-explicit decision aids, standardise biomarker-result communication, and scale advocacy-linked navigation.

Introduction

Combination therapies (CTs) have become a cornerstone of modern oncology, driven by a deeper understanding of cancer biology and mechanisms of resistance. Single-agent treatments often fail to provide durable disease control because of the adaptive, heterogeneous nature of cancer cells; by integrating multiple modalities, CTs aim to enhance antitumour efficacy, target distinct molecular pathways, and reduce acquired resistance.[1, 2] The success of immune checkpoint inhibitors combined with targeted therapies in melanoma, non-small-cell lung cancer, and renal cell carcinoma demonstrates their potential to improve survival and quality of life,[3–5] and their role continues to grow across diverse cancer settings.[6–8] Advances in biomarker-driven precision medicine increasingly allow clinicians to tailor CT regimens on the basis of genomic and molecular profiling.[9]

Despite this progress, patients' awareness of their treatment options — including CTs and the rationale for their use — remains limited. That patients are often under-informed is well documented; less clear, and more useful for improving care, is where communication specifically breaks down, whether patients recognise those gaps in themselves, and whether the shortfall is a fixed feature of patients and disease

complexity or a modifiable property of how systems communicate. We therefore designed a survey not only to measure awareness of CTs and biomarker-driven care across a broad European population, but to interrogate the structure of the gap: the alignment between how informed patients feel and what they know, the balance between their understanding of benefits and of harms, the distinction between misinformation and uncertainty, and the extent of between-country variation. Each of these bears directly on which practice and policy responses are likely to work.

Methods

Survey development

We developed a 29-item questionnaire to evaluate cancer patients' knowledge and perceptions of combination therapies. The instrument was created by an advisory board of researchers and patient advocates and comprised multiple-choice and closed-ended items designed to be completed in 10–15 minutes. It captured demographics, treatment history, sources of information, awareness and understanding of CTs, biomarker testing experience, perceived benefits and risks, willingness to self-fund, and informational preferences. The questionnaire was translated into English, French, German, Italian, and Spanish, with translations reviewed by native-speaking patient representatives to preserve meaning and readability.

Dissemination and participants

The survey was hosted on the SurveyMonkey platform to ensure respondent anonymity and compliance with the EU General Data Protection Regulation (GDPR). It was disseminated through the Cancer Patients Europe (CPE) network and public social-media campaigns, remained open for 90 days, and targeted adult European cancer patients, survivors, and carers. Participation was voluntary and no personally identifying information was collected. Participant flow through the survey, including attrition at each stage, is shown in Online Resource 1.

Statistical analysis

Responses were analysed at the level of the individual respondent. A total of 1,446 responses were received. Because several items used conditional branching (for example, questions on combination therapies and biomarker testing were shown only to eligible respondents) and because some participants did not complete every section, the denominator varied across items; the relevant base (n) is reported alongside each result and in Tables 1–4, and percentages are calculated on the number of respondents answering each item. Participant flow is shown in Online Resource 1.

Two-sided 95% confidence intervals (CIs) for proportions were calculated using the Wilson score method, which provides coverage close to nominal even for proportions near 0 or 1.[13] Because responses could be linked within respondents, the correspondence between perceived and actual

understanding was assessed directly by cross-tabulation rather than inferred from marginal proportions. The comparison of benefit and harm literacy uses McNemar's test with continuity correction, since both items were answered by the same respondents and the observations are therefore paired; we report the discordant pairs, which carry the information in that comparison.[14] Between-country differences used self-reported country of residence rather than survey language as a proxy; free-text responses were harmonised to country names, and the five countries contributing more than 100 respondents were compared. For each single-choice item we applied Pearson χ^2 tests of homogeneity and report Cramér's V (0.1, 0.3, 0.5 denoting small, medium, large effects), with Holm–Bonferroni adjustment across the seven pre-specified comparisons. To establish whether country differences reflected demographic composition, we fitted a multivariable logistic regression for having been told about a combination approach, with country, age band, education, respondent type, facility type and lines of therapy as predictors; adjusted odds ratios are reported with 95% CIs. Expected cell counts exceeded 5 in all reported tests. Statistical significance was defined as a two-sided α of .05. Because the sample was a self-selected convenience sample, analyses remain descriptive and hypothesis-generating; no weighting or imputation was performed. Analyses were conducted in Python 3 (pandas, SciPy, statsmodels) and the analysis code is available with the data. The study is reported in accordance with STROBE and CHERRIES.[15]

Results

Respondent characteristics

A total of 1,446 responses were collected from across Europe, of whom 1,236 completed the core demographic items (Table 1). Most participants were women (85.8%) and older: 61.9% were older than 60 years and only 2.0% were younger than 40. Geographically, 59.6% lived in towns of fewer than 50,000 inhabitants – including 31.8% in villages or rural communities – while 12.7% lived in major metropolitan areas. Self-reported country of residence was available for 1,216 respondents: France (26.2%), the United Kingdom (23.9%), Germany (20.1%), Italy (14.6%) and Spain (13.6%) together accounted for 98.4%. Educational attainment varied, with 54.0% having completed secondary school and 39.5% holding a university or postgraduate degree.

Table 1

Characteristics of survey respondents. Denominators vary by item because of incomplete responses; the base (n) is shown for each characteristic

Characteristic	Category	n (%)
Gender (n = 1,236)	Female	1,060 (85.8)
	Male	169 (13.7)
	Prefer not to say	7 (0.6)
Age group (n = 1,236)	< 25 years	6 (0.5)
	25–39 years	19 (1.5)
	40–49 years	142 (11.5)
	50–59 years	304 (24.6)
	60–69 years	421 (34.1)
	≥ 70 years	344 (27.8)
Residence (n = 1,236)	Major city (> 500,000)	157 (12.7)
	Large city (200,000–500,000)	124 (10.0)
	Medium city (50,000–200,000)	219 (17.7)
	Small city/town (< 50,000)	343 (27.8)
	Village/rural (< 7,500)	393 (31.8)
Education (n = 1,236)	Primary school	80 (6.5)
	Secondary school	668 (54.0)
	University	345 (27.9)
	Postgraduate	143 (11.6)
Respondent type (n = 1,236)	Current patient	968 (78.3)
	Cancer survivor	231 (18.7)
	Carer of a patient	37 (3.0)
Treatment facility (n = 1,236)	Major centre, specialised oncology team	649 (52.5)
	Medium hospital, oncology dept.	347 (28.1)
	Outpatient practice / day centre	110 (8.9)
	Small regional hospital/clinic	92 (7.4)
	Major centre, no specialised team	25 (2.0)

Characteristic	Category	n (%)
	Medium hospital, no oncology dept.	13 (1.1)
Lines of therapy (n = 1,103)	1	783 (71.0)
	2	163 (14.8)
	3	92 (8.3)
	≥ 4	65 (5.9)

Regarding cancer status, 78.3% were current patients, 18.7% survivors, and 3.0% carers. Just over half (52.5%) were treated at major centralised hospitals with a specialised oncology team, and 28.1% at medium-sized hospitals with an oncology department. Among the 1,103 respondents reporting treatment history, 29.0% had undergone two or more lines of therapy and 14.2% three or more.

Perceived versus actual information adequacy

A central finding was a measurable dissociation between how well informed patients felt and what they actually knew. Among the 1,103 respondents who reported on the information they had received, 70.4% (95% CI, 67.6–73.0) felt they had been given enough information about their treatment options. Because responses could be linked within respondents, this perception can be compared directly with what the same individuals reported knowing. Of the 985 respondents answering both items, 254 (25.8%; 95% CI, 23.2–28.6) both felt adequately informed and reported that their oncologist had never discussed a combination approach; a further 92 felt adequately informed but could not recall whether such a discussion had occurred (Table 2). The corresponding figure for biomarker testing was 25.9% (95% CI, 23.2–28.8) of 937. Feeling informed and being informed were associated ($\chi^2 = 70.7$, $df = 2$, $P < .001$; Cramér's $V = 0.27$), so patient-reported adequacy is not unrelated to actual knowledge; rather, it misclassifies approximately one respondent in four. These values are more than ten percentage points above the minimum implied by the marginal proportions alone, so the discordance is a measured quantity and not an artefact of comparing separate denominators.

Table 2

Perceived versus actual understanding, and the paired comparison of benefit and harm literacy. Because responses are linked within respondents, the discordance is measured directly. The benefit–harm comparison uses McNemar’s test, the discordant pairs carrying the information. Between-country comparisons are reported in Online Resource 2

Perceived versus actual understanding	n	%	95% CI	Test
Felt adequately informed (n = 1,103)	776	70.4	67.6–73.0	—
Felt informed AND never told about a combination approach (n = 985)	254	25.8	23.2–28.6	$\chi^2 = 70.7$, df = 2, P < .001, V = 0.27
Felt informed AND could not recall such a discussion (n = 985)	92	9.3	7.7–11.3	—
Felt informed AND did not know if biomarkers guided care (n = 937)	243	25.9	23.2–28.8	$\chi^2 = 25.6$, df = 2, P < .001, V = 0.17
Benefit versus harm literacy (paired, n = 985)				
Could not name any potential harm	301	30.6	27.8–33.5	McNemar $\chi^2 = 77.3$, df = 1, P < .001
Could not name any potential benefit	161	16.3	14.2–18.8	—
Discordant pairs: benefit named, no harm (195) vs harm named, no benefit (55)	—	—	—	ratio 3.5 : 1

Sources of information

Medical professionals, primarily oncologists, were the dominant source of information on treatment options, cited by 72.3% (95% CI, 69.6–74.9) of the 1,103 respondents answering this item, followed by the internet (36.4%; 95% CI, 33.7–39.3). Patient associations were cited by 11.1% (95% CI, 9.3–13.0), and use of this channel differed sharply across countries ($\chi^2 = 53.8$, df = 4, P < .001; V = 0.22, a medium effect): 28.1% among Spanish respondents (95% CI, 21.4–35.9) against 6.9–9.8% elsewhere. When those aware of CTs were asked where they had learned about them, medical professionals again predominated, underscoring a largely clinician-dependent information ecosystem.

Awareness and understanding of combination therapies

Awareness of the term “combination therapy” was low: 44.6% of 1,062 respondents had heard of it (95% CI, 41.7–47.6), while 46.8% had never heard the term and 8.6% could not recall (Table 3). Awareness differed significantly across countries ($\chi^2 = 46.2$, df = 8, Holm-adjusted P < .001; V = 0.15). Among the 985 respondents who expressed an understanding of the term, 37.0% understood it as the concurrent use of multiple anti-cancer drugs and 36.1% recognised both the multi-drug and multi-modality meanings (Table 3). Notably, 45.9% (95% CI, 42.8–49.0) reported that their oncologist had never

informed them about the possibility of a combination approach, and 41.8% confirmed such a discussion had taken place; this too varied by country ($\chi^2 = 42.3$, $df = 8$, adjusted $P < .001$; $V = 0.15$), from 33.2% never informed in Germany to 58.8% in Spain. Despite these gaps, 71.2% (95% CI, 68.3–73.9) wished to learn more about CTs directly from their treating physician ($\chi^2 = 63.9$, $df = 8$, adjusted $P < .001$; $V = 0.18$).

Table 3

Awareness, communication, and attitudes toward combination therapies and biomarker testing.
Percentages are of respondents answering each item

Domain / Survey item	Response	n (%)
Heard the term “combination therapy” (n = 1,062)	No	497 (46.8)
	Yes	474 (44.6)
	Do not know / recall	91 (8.6)
Understanding of the term among aware respondents (n = 985)	Different anti-cancer drugs	364 (37.0)
	All of the above (both meanings)	356 (36.1)
	Different treatment methods	139 (14.1)
	Do not know / recall	126 (12.8)
Oncologist discussed a combination approach (n = 985)	No	452 (45.9)
	Yes	412 (41.8)
	Do not know / recall	121 (12.3)
Wants more information from oncologist (n = 985)	Yes	701 (71.2)
	No	198 (20.1)
	Do not know / recall	86 (8.7)
Biomarker testing before treatment (n = 937)	Yes	367 (39.2)
	No	316 (33.7)
	Do not know / recall	254 (27.1)
Aware results guided treatment choice (n = 937)	Yes	387 (41.3)
	Do not know / recall	373 (39.8)

Domain / Survey item	Response	n (%)
	No	177 (18.9)
Most valued potential benefit of combinations (n = 937)	Effectiveness / survival	549 (58.6)
	Overcoming resistance / recurrence	245 (26.1)
	Could not identify a benefit	85 (9.1)
	Fewer side effects	58 (6.2)
Would self-fund a non-reimbursed combination (n = 937)	Probably could not afford it	510 (54.4)
	Yes	287 (30.6)
	Do not know / recall	94 (10.0)
	No	46 (4.9)

Biomarker testing awareness

Awareness of biomarker testing was similarly limited (Fig. 1; Table 3). Among the 937 respondents answering this section, 33.7% (95% CI, 30.8–36.8) reported that they had not undergone biomarker testing before starting treatment, and a further 27.1% did not know or could not recall whether they had been tested. Only 41.3% (95% CI, 38.2–44.5) were aware that their test results had been used to inform treatment decisions, while 39.8% did not know and 18.9% believed the results had not been used. Both reported testing ($\chi^2 = 25.5$, df = 8, adjusted P = .001; V = 0.12) and awareness that results guided treatment ($\chi^2 = 28.9$, df = 8, adjusted P < .001; V = 0.13) differed across countries. Together these findings suggest that even when biomarker testing occurs, its purpose and role are frequently not communicated in a way patients retain.

Perceived benefits, risks, and willingness to pay

When asked which potential benefit of CTs they valued most, 58.6% prioritised improved treatment effectiveness and survival (95% CI, 55.4–61.7), 26.1% identified overcoming tumour resistance and recurrence, and only 6.2% selected a reduction in side effects (95% CI, 4.8–7.9); 9.1% could not identify any benefit (Fig. 2). The distribution differed across countries ($\chi^2 = 47.2$, df = 12, adjusted P < .001; V = 0.13), but the primacy of survival over reduced toxicity was consistent throughout. Because the same respondents reported both, benefit and harm literacy can be compared as paired observations. Of 985 respondents, 30.6% (95% CI, 27.8–33.5) could not name any potential negative effect of combinations, against 16.3% (95% CI, 14.2–18.8) who could not name a benefit. The discordant pairs are decisive: 195 respondents could name a benefit but no harm, while only 55 showed the reverse pattern, a ratio of 3.5

to 1 (McNemar $\chi^2 = 77.3$, $df = 1$, $P < .001$). Current communication therefore conveys the promise of combinations more effectively than their risks, and does so within individual patients rather than merely on average.

Access and affordability emerged as a further concern. Although 30.6% (95% CI, 27.8–33.7) would consider self-funding a CT if it were available but not reimbursed, 54.4% (95% CI, 51.2–57.6) stated they probably could not afford to pay out of pocket; willingness to self-fund differed markedly by country ($\chi^2 = 61.7$, $df = 12$, adjusted $P < .001$; $V = 0.15$). When asked how they would prefer to receive further information about CTs, 78.2% chose their oncologist or healthcare team and 9.6% chose cancer associations.

Discussion

That many cancer patients are imperfectly informed about their treatment is not, in itself, a new observation. The contribution of this pan-European survey lies in four more specific findings that move beyond documenting low awareness and point to where, and how, communication should change. First, and most consequentially, feeling informed and being informed diverged measurably within individual patients: a quarter of respondents (25.8%) simultaneously reported that they had received enough information about their treatment options and that their oncologist had never discussed a combination approach, with an almost identical figure for biomarker testing. The two are not unrelated — patients who felt informed were more likely to have been told — but patient-reported information adequacy, the common proxy for communication quality in satisfaction surveys and quality dashboards, misclassifies roughly one patient in four. It should not be used as a stand-alone quality indicator. Objective checks of comprehension, such as teach-back, are needed to detect the gaps that satisfaction measures conceal. [23]

Second, patients' understanding of harms lagged systematically behind their understanding of benefits, and because both items were answered by the same people this can be established as a within-patient asymmetry rather than a difference between averages: 195 respondents could name a benefit of combination therapy but no harm, against 55 showing the reverse, a ratio of more than three to one (McNemar $P < .001$). This is not a generic "knowledge gap" but a directional bias in what is communicated, and it has a concrete consequence — consent to intensified, more toxic regimens may rest on an incomplete picture of risk. It argues for structured tools that force explicit presentation of toxicity, such as encounter decision aids, rather than for more information in general.[25] Third, the large share of "do not know" responses on biomarker items (27% unsure whether they were even tested; 40% unsure whether results were used) identifies uncertainty, distinct from misinformation, as a dominant failure mode. Patients are not holding incorrect beliefs so much as being left unable to account for decisions made on their behalf, consistent with evidence that the purpose of biomarker testing is frequently not conveyed in retainable terms.[18–20]

Fourth, the problem is not uniform, and its variation is informative. Awareness, communication and attitudes differed significantly across the five countries contributing most respondents, and use of patient advocacy organisations as an information source ranged fourfold, from 6.9–9.8% in most countries to 28.1% in Spain (Cramér’s $V = 0.22$). Crucially, these differences are not explained by who answered in each country. After adjustment for age, education, respondent type, facility type and lines of therapy, respondents in Italy remained twice as likely as those in the United Kingdom to have been told about a combination approach (adjusted OR 2.09; 95% CI 1.34–3.26) and those in Germany 1.6 times as likely (1.62; 1.07–2.45) (Table 4). If low awareness were simply a fixed property of patients or of the therapies’ complexity, it would not vary this much between health systems after demographic composition is accounted for. The variation instead localises the problem to modifiable features of how health systems and advocacy networks communicate – which reframes the issue from a patient-education deficit to a system-level communication design choice, and makes the better-performing settings a template rather than an anomaly.[16, 17] An unplanned observation deserves note: cancer survivors were substantially less likely than current patients to report having been told about a combination approach (adjusted OR 0.56; 95% CI 0.39–0.80), which may reflect a cohort effect from treatment in an earlier era, decay of recall, or both; these data cannot distinguish between them.

Table 4
Multivariable logistic regression for having been told about a combination approach (n = 866 complete cases). Adjusted for country, age band, education, respondent type, facility type, and lines of therapy. Age and facility terms are omitted; none reached significance

Predictor (reference category)	Adjusted OR	95% CI	P
Country: Italy (vs United Kingdom)	2.09	1.34–3.26	.001
Country: Germany (vs United Kingdom)	1.62	1.07–2.45	.022
Country: France (vs United Kingdom)	1.36	0.93–1.98	.109
Country: Spain (vs United Kingdom)	0.71	0.44–1.16	.174
Cancer survivor (vs current patient)	0.56	0.39–0.80	.001
Carer (vs current patient)	0.69	0.30–1.61	.388
University education (vs primary/secondary)	1.68	1.05–2.70	.031
≥ 2 lines of therapy (vs 1)	1.19	0.89–1.59	.252

Implications for clinical practice

Because the gaps we identified are gaps in communication rather than in the therapies themselves, they are amenable to concrete, practice-level intervention. We suggest four implementable levers, ordered from the individual consultation outward to the health system. First, at the point of care, the combination nature of a regimen should be named explicitly and its rationale, expected benefits, and specific toxicities described in plain language, with understanding confirmed rather than assumed. The teach-

back method — asking patients to restate the plan in their own words — improves comprehension and self-management across chronic diseases and adds little consultation time,[23] directly addressing the retention problem signalled by our high “do not know” rates. Question prompt lists, brief structured sheets of candidate questions endorsed by the clinician, reliably increase patients’ participation and question-asking in oncology consultations and are low-cost to deploy;[24] they are well suited to the 71.2% of our respondents who wanted more information but may not know what to ask.

Second, for preference-sensitive choices — for example, a more toxic combination versus a better-tolerated single agent — validated patient decision aids make the options, benefits, and harms explicit and improve knowledge, accurate risk perception, and value-concordant choice without lengthening consultations or causing harm.[25] This matters because some combinations, notably dual checkpoint inhibition with nivolumab plus ipilimumab, carry substantially higher toxicity than single-agent regimens, [10, 11] and because the preference literature shows that although efficacy usually dominates, many patients will trade survival gains to limit toxicity once trade-offs are made explicit, with preferences varying widely between individuals.[21, 22] Given the near-tenfold preference for survival over tolerability we observed, decision aids that surface toxicity explicitly are particularly important to ensure choices reflect informed values rather than an untested assumption of survival-at-all-costs. Third, biomarker result communication should be standardised: a short, plain-language explanation of what was tested and how the result shapes treatment — embedded in the care pathway or generated from the molecular tumour board — would address the 40% who did not know whether their results guided therapy, and could be delivered by the wider care team rather than resting solely on the oncologist.

Fourth, at the system level, patient navigation offers a route to deliver this education equitably. Navigation programmes reduce delays, improve treatment initiation and adherence, and raise satisfaction, with the largest gains among disadvantaged and underserved populations — precisely the rural and smaller-urban patients who predominated in our sample.[26] Navigators, whether nurse- or lay-led, are a natural vehicle for combination-therapy and biomarker education and for connecting patients to advocacy organisations. The marked between-country variation in advocacy-organisation use (28.1% in Spain versus 6.9–9.8% elsewhere; $V = 0.22$) suggests that where advocacy groups are embedded they become a meaningful, trusted channel; co-producing plain-language CT and biomarker materials with these organisations, and signposting them routinely, is a low-cost way to scale that model. Because medical professionals remain the dominant source (72.3%) and 78% of patients preferred to receive information from their clinical team, these channels should complement rather than replace clinician-led communication.

Affordability must be addressed alongside information, or better-informed patients will simply be more aware of therapies they cannot obtain. That 30.6% would consider self-funding a non-reimbursed CT signals strong perceived value, but the 54.4% who reported they probably could not afford to do so — against a backdrop of restricted reimbursement and heterogeneous access across Europe[12] — underscores a real risk that ability to pay, rather than clinical need, determines access. Embedding CT and biomarker education into survivorship care plans and national cancer-control programmes, and

pairing it with financial-navigation support, would help ensure that improved awareness translates into more equitable access rather than widened disparity.

Limitations

Several limitations should be considered. The convenience sample recruited through advocacy networks and social media over-represents women, older adults, and residents of smaller towns, and cannot be assumed representative of all European cancer patients; the predominance of engaged, self-selected respondents may overestimate awareness, so the gaps reported here are likely conservative. Confidence intervals and P values describe this respondent sample rather than the wider population. Self-reported awareness is subject to recall and comprehension bias, so gaps may partly reflect communication that was not retained rather than never delivered; that distinction matters for interpretation but not for the conclusion that patients cannot account for their own treatment decisions. Denominators varied because of branching and attrition (Online Resource 1), and respondents reaching later items may differ from those who did not. Country of residence was self-reported free text and harmonised for analysis; a few entries naming a town or region were assigned to the country of the survey language. With a sample this large, small differences reach significance, which is why effect sizes accompany all P values; all were small to medium. The model adjusts for measured characteristics only, and residual confounding by disease stage, tumour type and time since diagnosis cannot be excluded. Findings may not generalise to all European settings.

Conclusion

The value of this survey is not that cancer patients are under-informed — which is established — but that it quantifies where the standard responses fail and what should change. Three findings redirect practice. Information adequacy as patients report it is measurably misleading: a quarter of respondents felt sufficiently informed while lacking basic knowledge of the treatment decisions being made, so satisfaction-based information metrics should be replaced by objective comprehension checks such as teach-back. Communication is systematically skewed toward benefits over harms within individual patients, so consent for intensified combination regimens needs tools that force explicit disclosure of toxicity rather than more information in general. And because awareness and communication differ between countries even after adjustment for who responded, the deficit is a modifiable property of health-system and advocacy communication rather than an immutable feature of patients or of treatment complexity — meaning the better-performing settings define a reachable standard. Acting on these points is low-cost and specific: substitute comprehension checks for satisfaction proxies, embed toxicity-explicit decision aids at the point of combination-therapy decisions, standardise plain-language reporting of biomarker results, and scale the advocacy-linked, navigator-supported models already working in some countries — paired with financial navigation so that better information yields more equitable access rather than awareness of unaffordable care. These are testable service changes, and evaluating their effect on patient comprehension and value-concordant decision-making is the logical next step.

Statements and Declarations

Relevance statement: This study shows that patient-reported information adequacy – widely used as a proxy for communication quality in cancer services – conceals substantial gaps in what patients actually understand about combination therapies and biomarker-guided treatment. The findings identify four specific, low-cost and directly testable changes to supportive care practice and policy: replacing satisfaction-based information metrics with objective comprehension checks, embedding toxicity-explicit decision aids at combination-therapy decision points, standardising plain-language communication of biomarker results, and scaling advocacy-linked patient navigation.

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Competing interests

F.-U. F. has received consulting and speaker fees from major pharmaceutical companies in the past and is personally acquainted with several individuals in these companies through professional collaborations over the past 30 years. None of these relationships influenced the content of this work or the conclusions presented in this manuscript.

M.G. is employed by the Office of Health Economics and has worked on projects funded by a variety of pharmaceutical companies. These activities are unrelated to the content of this manuscript.

C.B. is a treasurer of the Federación Española de Cáncer de Mama (FECMA). She also participates in patient advisory activities with EORTC, the European Medicines Agency (EMA) and BIG (Breast International Group). She takes part in patient advisory boards with the following pharma companies: Steamline Menarini, Pfizer, Novartis and Be One. FECMA receives financial support from the companies mentioned, as well as from Astra Zeneca and Lilly. Her roles are voluntary and unrelated to the preparation of this manuscript.

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The authors have no other competing financial or personal interests to declare.

Ethics approval

This was an anonymous, voluntary online survey that collected no personally identifying information and was conducted in line with the principles of the Declaration of Helsinki and in accordance with the EU General Data Protection Regulation.

Consent to participate

Informed consent to participate was obtained from all respondents at the start of the online survey; participation was voluntary and anonymous.

Consent to publish

Not applicable; the manuscript contains no individually identifying information.

Author contributions

F.-U. F. contributed to conceptualization, validation and writing editing and review.

M.G. contributed to conceptualization, validation and writing editing and review.

C.B. contributed to conceptualization, validation and writing editing and review.

A.C. contributed to study conception, design, validation and writing editing and review.

JJ.V. contributed to study conception, design, performed material preparation, data collection, analysis, drafted the manuscript, validation and writing editing and review.

All authors read, commented on, and approved the final manuscript.

Data availability

The de-identified respondent-level dataset and the analysis code that generates every result reported here are available from the corresponding author on reasonable request. No individually identifying data are included in the analysis dataset.

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Figures

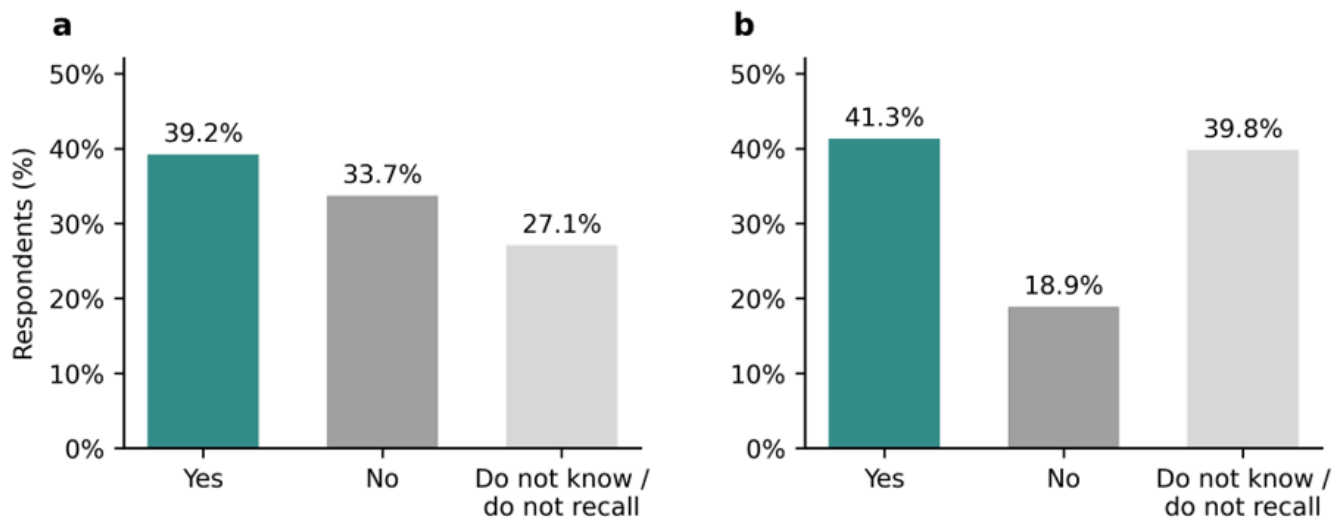


Figure 1

Patients' awareness of biomarker testing (n = 937). a Whether biomarker testing was carried out before treatment. b Whether the respondent was aware that test results informed the treatment decision

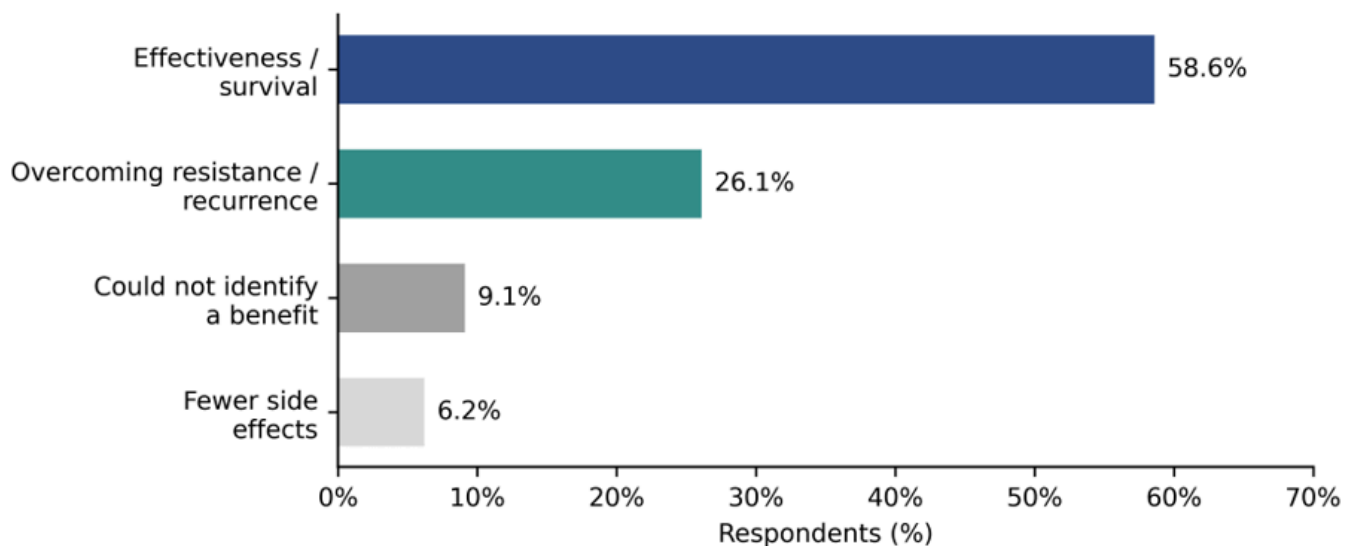


Figure 2

Most valued potential benefit of combination therapies (n = 937)

Supplementary Files

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