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Biomarkers use in psycho-oncology practice: Are we there yet?

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Editorial

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Introduction

Psychiatric comorbidities are frequent in cancer care settings. In fact, patients with cancer are 2 to 3 times more likely to experience depression than the general population, with a prevalence that can reach 14% (Panjwani and Li 2021). Survivors are also at risk to suffer from anxiety disorders, with a reported prevalence estimated to 17% (Mitchell et al. 2013). Such psychiatric comorbidities are associated with negative health outcomes, including decreased quality of life. Therefore, any innovation that could improve early identification of psychiatric disorders and improve access to treatment warrants consideration and empirical evaluation in cancer care.

In the past decades, biomarkers have been studied for research purposes and used as an innovation in various medical contexts. With the emergence of precision medicine and individualized therapy, the value of biomarkers has increased considerably. They have been linked to the etiology of many diseases across the life span (Furman et al. 2019). In the mental health domain, inflammatory markers, such as cytokines and cortisol levels, have been used to study depression etiology and treatment response (Meshkat et al. 2023), including for medically ill patients (Rosenblat et al. 2020). The hope is that biomarkers would eventually guide interventions and enhance treatment response in patients with mood disorders (Miller and Raison 2016).

Based on these emerging data, it is interesting to reflect on biomarkers use in the field of psycho-oncology. Psychometric measures are already standard care in cancer care, and some biological markers such as thyroid-stimulating hormones are often monitored when ruling out hypothyroidism in a case of a depressive presentation. Some experts raised the question whether biomarkers would already be relevant in psycho-oncology practice as several appear promising (Chen et al. 2022; Eddington et al. 2021; Fertig and Hayes 2001; Kim et al. 2022; Koehler et al. 2022; Lambert et al. 2020; Li et al. 2017, 2011; Mitchell et al. 2021; O'Toole et al. 2018; Patterson et al. 2022; Pedro et al. 2021; Petrova et al. 2021a, 2021b; Rosenblat et al. 2020; Shi et al. 2020; Taylor et al. 2021; Vistad et al. 2021; Warth et al. 2021; Wiley et al. 2017; Zhou et al. 2021). However, to our knowledge, no specific one has been currently validated in psycho-oncology practice. There is indeed a lack of recommendations regarding their use in everyday practice. The purpose of this article is to discuss existing data on biomarkers use in that field and argue whether they should now be utilized in every practice.

A difficult path from research to clinical practice

Simply defined, a biomarker is a characteristic that is measured as an indicator of normal biological processes or responses to an exposure or intervention (Garcia-Gutierrez et al. 2020). Biomarkers may be identified at any moment occurring from the pathogenesis to the onset of clinical manifestations, diagnosis, treatment response, and recovery. Researchers and experts have distinguished several types of biomarkers based on their clinical application. A biomarker may meet multiple criteria for different uses or present specific features that enable its particular use (see Table 1 for examples).

In cancer care, the clinical use of both prognostic and predictive markers is growing. It ranges from screening, to assessing risk and prognosis, evaluating response to treatment, and detecting disease recurrence and progression (Lahoud et al. 2021). It is well established that cancer itself is associated with increased levels inflammatory biomarkers, which can then influence illness trajectory. Tumor biology and cancer treatments have also been hypothesized to have

Table 1. Potential uses of biomarkers in medical practice

Type of biomarker	Objective	Example
Diagnostic	To detect or confirm the presence of a disease	Level of protein S100B that is released by brain cells in response to injury can help diagnose traumatic brain injury (Wang et al. 2018).
Predictive	To predict the likelihood to develop any effect resulting from a clinical intervention	A protein biomarker HER2/neu that can be measured in patients with breast cancer can predict whether a patient is likely to respond to targeted therapy (Andorfer et al. 2011).
Prognostic	To identify the probability of develop a clinical event in patients with a clinical condition	Apolipoprotein B levels can be used to predict the risk of developing cardiovascular disease (Walldius and Jungner 2004).
Pharmacodynamic or response	To evaluate the response to a clinical intervention	In heart failure, brain natriuretic peptide levels can be used to evaluate the response to treatment (Doust et al. 2004).
Monitoring	To monitor the status of a disease and the response to the intervention	In diabetes, hemoglobin A1c can be used to monitor blood glucose control and the effectiveness of diabetes management (Saudek et al. 2006).
Safety	To evaluate the probability of developing signs of toxicity as an adverse event	In clozapine treatment for patient with schizophrenia, regular monitoring of white blood cell count is necessary to evaluate the risk of developing agranulocytosis as an adverse event (Sultan et al. 2017).
Susceptibility or risk	To measure the risk of an individual to develop a disease	In dementia, APOE4 is a genetic variant that is associated with an increased risk of developing Alzheimer's disease (Allan and Ebmeier 2011).

some impact on neuronal mechanisms through which neuroimmune phenomenon could lead to changes in behavior (Santos and Pyter 2018).

Researchers in the field of neurosciences have also shown interest in biomarkers. Psychiatric disorders, for example, have been associated with some endocrine and inflammatory perturbations, notably via the cytokine system. Chronic inflammation is now considered to increase susceptibility to depression (Li et al. 2011), as well as many other medical conditions (Furman et al. 2019). Higher plasma levels of cytokines, such as interleukin (IL)-1β, IL-6, and tumor necrosis factor-α (TNF-α), have been correlated with more severe depressive symptoms (Hassamal 2023). Emerging inflammatory biomarkers (including C-reactive protein, TNF-α, IL-6, COX-2) are now considered as potential treatment targets or prognostic predictors for depression phenotypes (Hassamal 2023). Psychological distress and burnout have been linked to increased cortisol level in some specific populations (Cipriani et al. 2021; Knight et al. 2021; Marcil et al. 2022). A recent study systematically reviewed randomized controlled trials on the effects of psychological interventions on pro-inflammatory biomarkers among a large adult population and concluded that such interventions contributed to reduce their levels (O'Toole et al. 2018; Pedro et al. 2021).

These findings although preliminary, limited in potency or tested mostly on animal models, highlight opportunities for further research into mechanisms and potential interventions for psychiatric symptoms' management among patients with cancer (Hassamal 2023; Shi et al. 2020). Inflammatory biomarkers could therefore be compelling candidates as susceptibility and monitoring biomarkers in psycho-oncology practice. Some researchers and experts have in fact pointed out the relevance of investigating use of biomarkers in that field, especially for depression (Breitbart et al. 2014; Fertig and Hayes 2001; Li et al. 2017, 2011; Menzies et al. 2005; Mitchell et al. 2013).

Emerging biomarkers

There is growing evidence suggesting that cancer-related depression etiology might be linked to neuroinflammation (Ahmad et al. 2021). Recent data have indicated that such phenomenon may disrupt serotonin neurotransmission shedding new insight on a complex interplay between the immune system and the pathophysiology of depressive disorders (Troubat et al. 2021). For years, it has been hypothesized that inflammatory cytokine-associated depression could even represent a subtype of depression in that population (Panjwani and Li 2021). A study conducted found associations between cytokines and the somatic and psychological symptoms of depression, compared to controlled subjects (Li et al. 2017). A recently published systematic review and meta-analysis concluded that the association between inflammation and depression among patients with cancer was robust, with moderate-to-large effect sizes (McFarland et al. 2022b). Another study reported that pro-inflammatory cytokines, such as TNF-α, have a good performance in predicting depression among patients with glioma (Li et al. 2022). McFarland and colleagues studied among 97 patients with metastatic cancer demonstrating that hypoalbuminemia may help establish the presence of anxiety or depression, and treatment refractoriness (McFarland et al. 2022a). The effectiveness of mind and body therapies for addressing some biomarkers of stress and immune function in people with cancer have been documented, although this evidence is limited (Deleemans et al. 2023). A cross-sectional analysis among 98 patients with metastatic lung cancer revealed that vitamin D deficiency was associated with depression (McFarland et al. 2022c).

Persistent challenges

Despite these emerging data, some limitations of the use of biomarkers in psycho-oncology must be acknowledged. First, association between biomarkers and comorbid psychiatric disorders in patients with cancer, including neurocognitive disorders and severe mental illnesses like psychosis or bipolar disorder, remains understudied beyond anxiety and depression. In fact, many psychological symptoms or psychiatric disorders other than depression can adversely affect patients with cancer. Even among patients' caregivers, the inflammatory responses were associated with psychological distress (Kim et al. 2022).

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Sleep problems are highly prevalent among patients with cancer (Savard and Morin 2001), and may persist into survivorship (Denlinger et al. 2014; Hall and Peppercorn 2020). Limited data recently raised the possibility that disruption of circadian activity rhythms and elevated cortisol awakening response among patients with breast cancer, may facilitate tumor promotion and progression (Cash et al. 2015), although such findings confirm correlations, not causality. Cancer-related cognitive impairment is another important problem found among cancer populations, which can have a major negative impact on a patient's quality of life and be complex to analyze (Orszaghova et al. 2021). Identifying biomarkers for cancer-related cognitive impairment could be helpful for clinicians.

Despite this literature is growing fast, the use of biomarkers in clinical practice in the field of psycho-oncology is not yet recommended in clinical guidelines. Translating this new knowledge remains a challenge. Studies still struggle with significant methodological issues such as sample sizes, or existing data quality. It seems not yet clear if clinicians should now use biomarkers in their practice despite these gaps and lack of experts' consensus. Their contribution within decision-making processes in everyday practice needs to pursue further investigation.

Conclusion

Biomarkers are being increasingly used in both mental health and cancer care research. However, little is known about the relevance of biomarkers in everyday psycho-oncology practice. Future studies should enhance understanding of the link between inflammation markers and psychiatric disorders in this population. Systematic reviews on that topic, including randomized controlled trials, could assist clinicians in enlightening this debate. Such data could help identify scalable and reliable biomarkers for the development of more effective treatments, including cancer-specific pharmacological or psychological treatments. In the realm of psycho-oncology, biomarkers hence offer potential interest to clinicians seeking to incorporate more biological parameters into their decision-making process, aligning with the principles of precision medicine. High-quality evidence is vital for improving clinical practices and delivering data-driven care that mostly benefits patients. Whether biomarkers have yet the potential to assist clinicians in making more informed treatment decisions, leading to wiser choices and potentially safeguarding patients from futile interventions, remains unanswered.

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References

Ahmad MH, Rizvi MA, Fatima M, *et al.* (2021) Pathophysiological implications of neuroinflammation mediated HPA axis dysregulation in the prognosis of cancer and depression. *Molecular and Cellular Endocrinology* **520**, 111093. doi:10.1016/j.mce.2020.111093

Allan CL and Ebmeier KP (2011) The influence of ApoE4 on clinical progression of dementia: a meta-analysis. *International Journal of Geriatric Psychiatry* **26**(5), 520–526. doi:10.1002/gps.2559

Andorfer CA, Necela BM, Thompson EA, *et al.* (2011) MicroRNA signatures: Clinical biomarkers for the diagnosis and treatment of breast cancer. *Trends in Molecular Medicine* **17**(6), 313–319. doi:10.1016/j.molmed.2011.01.006

Breitbart W, Rosenfeld B, Tobias K, *et al.* (2014) Depression, cytokines, and pancreatic cancer. *Psychooncology* **23**(3), 339–345. doi:10.1002/pon.3422

Cash E, Sephton SE, Chagpar AB, *et al.* (2015) Circadian disruption and biomarkers of tumor progression in breast cancer patients awaiting surgery. *Brain, Behavior, and Immunity* **48**, 102–114. doi:10.1016/j.bbi.2015.02.017

Chen WC, Boreta L, Braunstein SE, *et al.* (2022) Association of mental health diagnosis with race and all-cause mortality after a cancer diagnosis: Large-scale analysis of electronic health record data. *Cancer* **128**(2), 344–352. doi:10.1002/cncr.33903

Cipriani E, Kerr P, Longpre-Poirier C, *et al.* (2021) Commentary: Connecting cytokines to distress via cortisol concentrations. *Brain, Behavior, and Immunity* **95**, 21–22. doi:10.1016/j.bbi.2021.03.027

Deleemans JM, Mather H, Spiropoulos A, *et al.* (2023) Recent progress in mind-body therapies in cancer care. *Current Oncology Reports* **25**(4), 293–307. doi:10.1007/s11912-023-01373-w

Denlinger CS, Ligibel JA, Are M, *et al.* and National Comprehensive Cancer (2014) Survivorship: Sleep disorders, version 1.2014. *Journal of the National Comprehensive Cancer Network* **12**(5), 630–642. doi:10.6004/jnccn.2014.0067

Doust JA, Glasziou PP, Pietrzak E, *et al.* (2004) A systematic review of the diagnostic accuracy of natriuretic peptides for heart failure. *Archives of Internal Medicine* **164**(18), 1978–1984. doi:10.1001/archinte.164.18.1978

Eddington HS, McLeod M, Trickey AW, *et al.* (2021) Patient-reported distress and age-related stress biomarkers among colorectal cancer patients. *Cancer Medicine* **10**(11), 3604–3612. doi:10.1002/cam4.3914

Fertig DL and Hayes DF (2001) Considerations in using tumor markers: What the psycho-oncologist needs to know. *Psychooncology* **10**(5), 370–379. doi:10.1002/pon.514

Furman D, Campisi J, Verdin E, *et al.* (2019) Chronic inflammation in the etiology of disease across the life span. *Nature Medicine* **25**(12), 1822–1832. doi:10.1038/s41591-019-0675-0

Garcia-Gutierrez MS, Navarrete F, Sala F, *et al.* (2020) Biomarkers in psychiatry: Concept, definition, types and relevance to the clinical reality. *Frontiers in Psychiatry* **11**, 432. doi:10.3389/fpsyt.2020.00432

Hall DL and Peppercorn JM (2020) Wake up oncologists! It's time to help our patients with insomnia. *Journal of the National Comprehensive Cancer Network* **18**(12), 1738–1740. doi:10.6004/jnccn.2020.7682

Hassamal S (2023) Chronic stress, neuroinflammation, and depression: An overview of pathophysiological mechanisms and emerging anti-inflammatories. *Frontiers in Psychiatry* **14**, 1130989. doi:10.3389/fpsyt.2023.1130989

Kim Y, Kim H, Suh SY, *et al.* (2022) Association between inflammatory cytokines and caregiving distress in family caregivers of cancer patients. *Supportive Care in Cancer* **30**(2), 1715–1722. doi:10.1007/s00520-021-06578-y

Knight EL, Jiang Y, Rodriguez-Stanley J, *et al.* (2021) Perceived stress is linked to heightened biomarkers of inflammation via diurnal cortisol in a national sample of adults. *Brain, Behavior, and Immunity* **93**, 206–213. doi:10.1016/j.bbi.2021.01.015

Koehler F, Kessler J, Stoffel M, *et al.* (2022) Psychoneuroendocrinological effects of music therapy versus mindfulness in palliative care: Results from the 'Song of Life' randomized controlled trial. *Supportive Care in Cancer*: Official Journal of the Multinational Association of Supportive Care in Cancer **30**(1), 625–634. doi:10.1007/s00520-021-06435-y

Lahoud RM, O'Shea A, El-Mouhayyar C, *et al.* (2021) Tumour markers and their utility in imaging of abdominal and pelvic malignancies. *Clinical Radiology* **76**(2), 99–107. doi:10.1016/j.crad.2020.07.033

Lambert SD, Coumoundouros C, Hulbert-Williams NJ, *et al.* (2020) Building the capacity for psycho-Oncology research: A survey of the research barriers and training needs within the International Psycho-Oncology Society. *Journal of Psychosocial Oncology Research and Practice* **2**(3), e023. doi:10.1097/OR9.0000000000000023

Li M, Kouzmina E, McCusker M, *et al.* (2017) Cytokines and depression in cancer patients and caregivers. *Neuropsychiatric Disease and Treatment* **13**, 2903–2911. doi:10.2147/NDT.S144774

Li H, Shi X, Yang F, *et al.* (2022) Blood inflammatory cytokines as predictors of depression in patients with glioma. *Frontiers in Psychiatry* **13**, 930985. doi:10.3389/fpsyt.2022.930985

Li M, Soczynska JK and Kennedy SH (2011) Inflammatory biomarkers in depression: An opportunity for novel therapeutic interventions. *Current Psychiatry Reports* **13**(5), 316–320. doi:10.1007/s11920-011-0210-6

Marcil MJ, Cyr S, Marin MF, ***et al.*** (2022) Hair cortisol change at COVID-19 pandemic onset predicts burnout among health personnel. *Psychoneuroendocrinology* **138**, 105645. doi:10.1016/j.psyneuen.2021.105645

McFarland DC, Applebaum AJ, Bengtsen E, ***et al.*** (2022a) Potential use of albumin and neutrophil-to-lymphocyte ratio to guide the evaluation and treatment of cancer-related depression and anxiety. *Psychooncology* **31**(2), 306–315. doi:10.1002/pon.5811

McFarland DC, Doherty M, Atkinson TM, ***et al.*** (2022b) Cancer-related inflammation and depressive symptoms: Systematic review and meta-analysis. *Cancer* **128**(13), 2504–2519. doi:10.1002/cncr.34193

McFarland DC, Fernbach M, Breitbart WS, ***et al.*** (2022c) Prognosis in metastatic lung cancer: Vitamin D deficiency and depression-a cross-sectional analysis. *BMJ Supportive & Palliative Care* **12**(3), 339–346. doi:10.1136/bmjspcare-2020-002457

Menzies H, Chochinov HM and Breitbart W (2005) Cytokines, cancer and depression: Connecting the dots. *The Journal of Supportive Oncology* **3**(1), 55–57.

Meshkat S, Ho RC, Cao B, ***et al.*** (2023) Biomarkers of ketamine's antidepressant effect: An umbrella review. *Journal of Affective Disorders* **323**, 598–606. doi:10.1016/j.jad.2022.12.021

Miller AH and Raison CL (2016) The role of inflammation in depression: From evolutionary imperative to modern treatment target. *Nature Reviews Immunology* **16**(1), 22–34. doi:10.1038/nri.2015.5

Mitchell AJ, Ferguson DW, Gill J, ***et al.*** (2013) Depression and anxiety in long-term cancer survivors compared with spouses and healthy controls: A systematic review and meta-analysis. *The Lancet Oncology* **14**(8), 721–732. doi:10.1016/S1470-2045(13)70244-4

Mitchell HR, Kim Y, Carver CS, ***et al.*** (2021) Roles of age and sources of cancer caregiving stress in self-reported health and neuroendocrine biomarkers. *Psychology & Health* **36**(8), 952–966. doi:10.1080/08870446.2020.1800009

Orszaghova Z, Mego M and Chovanec M (2021) Long-term cognitive dysfunction in cancer survivors. *Frontiers in Molecular Biosciences* **8**, 770413. doi:10.3389/fmolb.2021.770413

O'Toole MS, Bovbjerg DH, Renna ME, ***et al.*** (2018) Effects of psychological interventions on systemic levels of inflammatory biomarkers in humans: A systematic review and meta-analysis. *Brain, Behavior, and Immunity* **74**, 68–78. doi:10.1016/j.bbi.2018.04.005

Panjwani AA and Li M (2021) Recent trends in the management of depression in persons with cancer. *Current Opinion in Psychiatry* **34**(5), 448–459. doi:10.1097/YCO.0000000000000727

Patterson JM, Lu L, Watson LJ, ***et al.*** (2022) Associations between markers of social functioning and depression and quality of life in survivors of head and neck cancer: Findings from the Head and Neck Cancer 5000 study. *Psychooncology* **31**(3), 478–485. doi:10.1002/pon.5830

Pedro J, Monteiro-Reis S, Carvalho-Maia C, ***et al.*** (2021) Evidence of psychological and biological effects of structured Mindfulness-Based Interventions for cancer patients and survivors: A meta-review. *Psychooncology* **30**(11), 1836–1848. doi:10.1002/pon.5771

Petrova D, Catena A, Rodriguez-Barranco M, ***et al.*** (2021a) Physical comorbidities and depression in recent and long-term adult cancer survivors: NHANES 2007-2018. *Cancers (Basel)* **13**(13), 3368. doi:10.3390/cancers13133368

Petrova D, Redondo-Sanchez D, Rodriguez-Barranco M, ***et al.*** (2021b) Physical comorbidities as a marker for high risk of psychological distress in cancer patients. *Psychooncology* **30**(7), 1160–1166. doi:10.1002/pon.5632

Rosenblat JD, Kurdyak P, Cosci F, ***et al.*** (2020) Depression in the medically ill. *Australian & New Zealand Journal of Psychiatry* **54**(4), 346–366. doi:10.1177/0004867419888576

Santos JC and Pyter LM (2018) Neuroimmunology of behavioral comorbidities associated with cancer and cancer treatments. *Frontiers in Immunology* **9**, 1195. doi:10.3389/fimmu.2018.01195

Saudek CD, Derr RL and Kalyani RR (2006) Assessing glycemia in diabetes using self-monitoring blood glucose and hemoglobin A1c. *JAMA* **295**(14), 1688–1697. doi:10.1001/jama.295.14.1688

Savard J and Morin CM (2001) Insomnia in the context of cancer: A review of a neglected problem. *Journal of Clinical Oncology* **19**(3), 895–908. doi:10.1200/JCO.2001.19.3.895

Shi W, Misra S, Li M, ***et al.*** (2020) Inflammatory biomarkers, hematopoietic stem cells, and symptoms in breast cancer patients undergoing adjuvant radiation therapy. *JNCI Cancer Spectrum* **4**(5), kaa037. doi:10.1093/jncics/pkaa037

Sultan RS, Olfson M, Correll CU, ***et al.*** (2017) Evaluating the Effect of the Changes in FDA Guidelines for Clozapine Monitoring. *The Journal of Clinical Psychiatry* **78**(8), e933–e939. doi:10.4088/JCP.16m11152

Taylor MR, Scott SR, Steineck A, ***et al.*** (2021) Objectifying the subjective: The use of heart rate variability as a psychosocial symptom biomarker in hospice and palliative care research. *Journal of Pain and Symptom Management* **62**(3), e315–e321. doi:10.1016/j.jpainsymman.2021.04.015

Troubat R, Barone P, Leman S, ***et al.*** (2021) Neuroinflammation and depression: A review. *European Journal of Neuroscience* **53**(1), 151–171. doi:10.1111/ejn.14720

Vistad I, Skorstad M, Demmelmaier I, ***et al.*** (2021) Lifestyle and Empowerment Techniques in Survivorship of Gynaecologic Oncology (LETSGO study): A study protocol for a multicentre longitudinal interventional study using mobile health technology and biobanking. *BMJ Open* **11**(7), e050930. doi:10.1136/bmjopen-2021-050930

Walldius G and Jungner I (2004) Apolipoprotein B and apolipoprotein A-I: risk indicators of coronary heart disease and targets for lipid-modifying therapy. *Journal of Internal Medicine* **255**(2), 188–205. doi:10.1046/j.1365-2796.2003.01276.x

Wang KK, Yang Z, Zhu T, ***et al.*** (2018) An update on diagnostic and prognostic biomarkers for traumatic brain injury. *Expert Review of Molecular Diagnostics* **18**(2), 165–180. doi:10.1080/14737159.2018.1428089

Warth M, Koehler F, Brehmen M, ***et al.*** (2021) "Song of Life": Results of a multicenter randomized trial on the effects of biographical music therapy in palliative care. *Palliative Medicine* **35**(6), 1126–1136. doi:10.1177/02692163211010394

Wiley JF, Bei B, Bower JE, ***et al.*** (2017) Relationship of psychosocial resources with allostatic load: A systematic review. *Psychosomatic Medicine* **79**(3), 283–292. doi:10.1097/PSY.0000000000000395

Zhou T, Li M, Xiao Z, ***et al.*** (2021) Chronic stress-induced gene changes in vitro and in vivo: Potential biomarkers associated with depression and cancer based on circRNA- and lncRNA-associated ceRNA networks. *Frontiers in Oncology* **11**, 744251. doi:10.3389/fonc.2021.744251