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Clinical Impact of Liquid Biopsy in Prostatic Cancer: A Literature Review

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ABSTRACT The most prev amost prev abstract alent solid tumor in men worldwide is prostate cancer. The need for biomarkers to guide management choices is critical given the frequency of prostate cancer and its relatively lengthy clinical course. Based on a patient's unique risk stratification, which considers pathologic characteristics from a prostate biopsy, prostate-specific antigen (PSA) level, imaging, and other patient factors, decisions about localized prostate cancer treatment options, such as active surveillance, surgical excision, or targeted radiation, are made. An attractive method for thorough cancer analysis is to use "liquid biopsies" made up of analytes from a peripheral blood draw. These methods can be used as prognostic and predictive biomarkers as well as ready tissue sources for molecular profiling during the course of a disease and are straightforward, safe, and simple to repeat. Researchers conduct an examination of articles that are in accordance with the issue to be studied. Articles used in literature review are obtained through the database of international journal providers through PubMed, we investigated eleven clinical studies and discussed what happened in these clinical studies and the extent of the effectiveness of liquid biopsy in prostatic cancer, in one study there was relative impact of common circulating tumor DNA alterations on patient response to the most widely used large, randomize advanced prostate cancer. Other studies reported that ZNF660 methylation analysis can potentially help to stratify low-/intermediate-grade PCs into indolent vs. more aggressive subtypes. Another study found that tumor-derived biomarkers in platelets of CRPC patients enabled prediction of the outcome after abiraterone therapy with higher accuracy than baseline serum PSA or PSA response. One study reported that de novo positive CTC count after androgen deprivation therapy is probably due to a passive mechanism associated with the destruction of the tumor. In this review, we suggest that liquid biopsy could be used as biomarker for prostatic cancer, Further studies are needed to enhance liquid biopsy efficacy.

INDEX TERMS Prostate-specific antigen, Liquid Biopsy, Biomarker, Pathogenic

I. INTRODUCTION

Despite the fact that tissue biopsies are now the gold standard for tumor profiling, this approach has numerous drawbacks, including the fact that it is intrusive, hazardous, and difficult to obtain in particular anatomical regions in addition to giving a limited image of the tumor profile. In actuality, tumors are heterogeneous structures that contain a variety of cell subpopulations with varied mutations. Additionally, during time, tumor cells experience dynamic genetic and epigenetic alterations (for instance, as a result of treatment stress), which further increases tumoral heterogeneity and creates differences between primary and metastatic lesions. As a result, the geographically and temporally restricted tissue biopsies are unable to accurately depict the total tumor profile, to capture modifications from various places, and as a result, to track the development of the disease.

Due to this, research in oncology has recently concentrated on liquid biopsies, which rely on the detection of cancer-derived components, such as circulating tumor cells (CTCs), circulating tumor DNA (ctDNA), RNA, extracellular vesicles (EVs), and tumor educated platelets (TEPs), in the biofluids of patients. These components provide genomic, epigenetic, transcriptomic, and proteomic information about tumors and metastatic sites. Cancer screening, diagnosis, and prognosis will all be improved by the use of liquid biopsies as a clinical tool [1]. FIGURE 1.

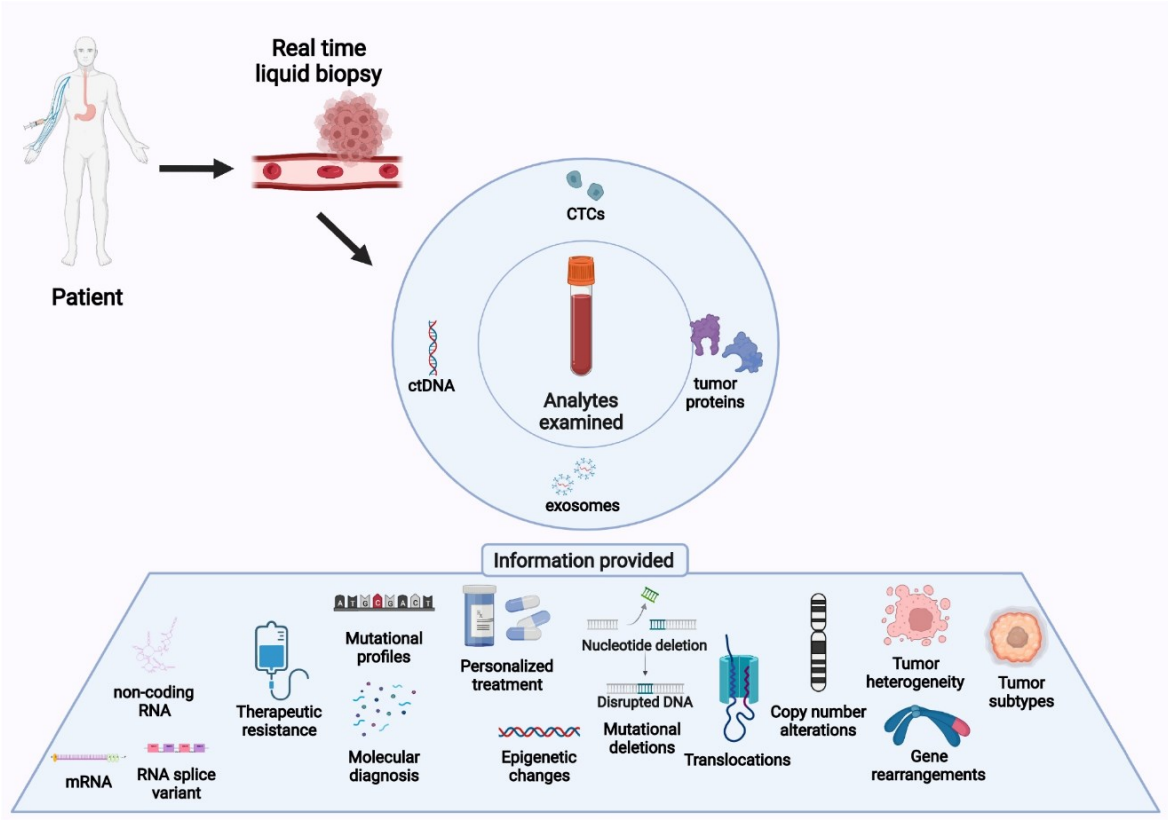

FIGURE 1. Entities analyzed in liquid biopsies and their application [2]

One of the most prevalent cancers in males worldwide is prostate cancer. Prostate cancer was recorded as 1,276,106 new cases and 358,989 deaths worldwide in 2018, according to GLOBOCAN, with industrialized nations having a greater prevalence. Around 80,000 people worldwide pass away from prostate cancer each year, with an average of 190,000 new cases diagnosed each year. Prostate cancer incidence varies across the globe depending on the area and ethnicity [3]. FIGURE 2.

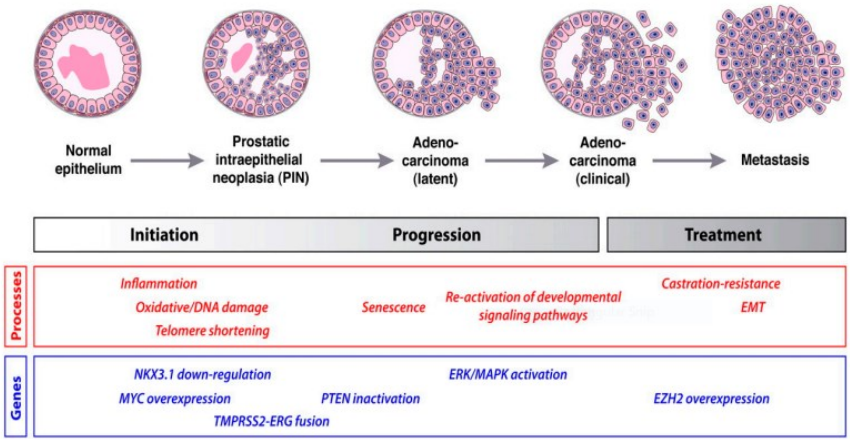

FIGURE 2. Stages of prostate cancer [4]

Standard diagnostic techniques for detecting prostate cancer include a DRE to assign clinical stage and a blood-based study of PSA levels as well as MRI. DRE, which involves physically palpating the prostate to evaluate gland size, texture, and stiffness, has a positive predictive value of 5–30% for identifying prostate cancer in males with PSA levels under 2 ng/ml. An aberrant DRE result, which is linked to a poorer differentiation grade, calls for a prostate biopsy, but

histological confirmation is required for a conclusive diagnosis. A better independent predictor of prostate cancer than DRE is serum PSA measurement, which supports attempts to diagnose the disease. Unfortunately, DRE and PSA testing may both be abnormal even in the absence of prostate cancer (false-positive) and may also be normal even when prostate cancer is present (false-negative) [5]. Based on data from PubMed database Liquid Biopsy has emerged as a minimally invasive biomarker for tumor molecular profiling. Here, we give a summary of what is currently known about the biological characteristics of liquid biopsy, for new approaches to liquid biopsy analysis to be developed, a deeper comprehension of liquid biopsy is necessary. From this, it is necessary to conduct an in-depth study. Therefore, we investigated clinical studies and discussed what happened in these clinical studies and the extent of the effectiveness of liquid biopsy as noninvasive biomarker in cancers.

II.METHODS

Researchers conduct an examination of articles that are in accordance with the issue to be studied. Determination of literature search keywords (search string based on PI (E) COT framework (P=patient/problem; I/E=exposure /implementation; C= control/comparison intervention, O=outcome, T=time) because a good question will help determine the scope of the review and help the strategy of finding the article. Articles used in literature review are obtained through the database of international journal providers through PubMed, from 2015-2022, Clinical Trials only. Author opens www.PubMed.com. Researchers wrote keywords according to MESH (Medical Subject Heading) namely “Liquid Biopsy”, “Prostatic Cancer”, and selected full text. 1.Inclusion Criteria Population or sample is Prostatic Cancer. 2.Exclusion Criteria Population or sample other than Prostatic Cancer.

TABLE 2
Summary of Literature Review Results

Title	Design and Samples	Results
Circulating Tumor DNA Genomics Correlate with Resistance to Abiraterone and Enzalutamide in Prostate Cancer [6] (2018)	Randomized Clinical Trial, 202 Patients	Although detection of AR amplification–ns did not outperform standard prognostic biomarkers, AR gene structural rearrangements truncating the ligand binding domain were identified in several patients with primary resistance. These findings establish genomic drivers of resistance to first-line AR-directed therapy in mCRPC and identify potential minimally invasive biomarkers. Significance: Leveraging plasma specimens collected in a large, randomized phase II trial, we report the relative impact of common circulating tumor DNA alterations on patient response to the most widely used large, randomized advanced prostate cancer. Our findings suggest that liquid biopsy analysis can guide the use of AR-targeted therapy in general practice.
Biomarker potential of ST6GALNAC3 and ZNF660 promoter hypermethylation in prostate cancer tissue and liquid biopsies [7]	Radical prostatectomy cohort. 110 nonmalignant (NM) and 705 PC prostate cancer tissue samples.	hypermethylation of ST6GALNAC3 and ZNF660 was highly cancer-specific with areas under the curve (AUC) of receiver operating characteristic (ROC) curve analysis of 0.917-0.995 and 0.846-0.903, respectively. Furthermore, ZNF660 hypermethylation was significantly associated with biochemical recurrence in two radical prostatectomy (RP) cohorts of 158 and 392 patients and remained significant also in the subsets of patients with Gleason score ≤7 (univariate Cox regression and log-rank tests, $P < 0.05$), suggesting that ZNF660 methylation analysis can potentially help to stratify low-/intermediate-grade PCs into indolent vs. more aggressive subtypes.
Association of Serum Carotenoids and Retinoids with Intraprostatic Inflammation in Men without Prostate Cancer or Clinical Indication for Biopsy in the Placebo Arm of the Prostate Cancer Prevention Trial [8]	Randomized Clinical Trial 235 patients	None of the carotenoids or retinol was associated with intraprostatic inflammation, except β-cryptoxanthin, which appeared to be positively associated with any core with inflammation [vs none, T2: OR (95% CI) = 2.67 (1.19, 5.99); T3: 1.80 (0.84, 3.82), P-trend = 0.12]. These findings suggest that common circulating carotenoids and retinol are not useful dietary intervention targets for preventing prostate cancer via modulating intraprostatic inflammation.

TABLE 2 (Continued)

Finasteride concentrations and prostate cancer risk: results from the Prostate Cancer Prevention Trial [9]	Case-Control Study Data for this nested case-control study are from the PCPT	Among men with detectable finasteride concentrations, there was no association between finasteride concentrations and prostate cancer risk, low-grade or high-grade, when finasteride concentration was analyzed as a continuous variable or categorized by cutoff points. Of the twenty-seven SNPs assessed in the enzyme target and metabolism pathway, five SNPs in two genes, CYP3A4 (rs2242480; rs4646437; rs4986910), and CYP3A5 (rs15524; rs776746) were significantly associated with modifying finasteride concentrations. These results suggest that finasteride exposure may reduce prostate cancer risk and finasteride concentrations are affected by genetic variations in genes responsible for altering its metabolism pathway
Molecular characterization of enzalutamide-treated bone metastatic castration-resistant prostate cancer [10]	Prospective phase 2 study 60 patients	Median time to treatment discontinuation was 22 wk (95% confidence interval, 19.9-29.6). Twenty-two (37%) patients exhibited primary resistance to enzalutamide, discontinuing treatment within 4 mo. Maximal prostate-specific antigen (PSA) decline ≥ 50% and ≥ 90% occurred in 27 (45%) and 13 (22%) patients, respectively. Following 8 wk of treatment, bone marrow and circulating testosterone levels increased. Pretreatment tumor nuclear AR overexpression (> 75%) and CYP17 (> 10%) expression were associated with benefit (p = 0.018). AR subcellular localization shift from the nucleus was confirmed in eight paired samples (with PSA decline) of 23 evaluable paired samples. Presence of an ARV7 variant was associated with primary resistance to enzalutamide (p = 0.018). Limited patient numbers warrant further validation
Platelets harbor prostate cancer biomarkers and the ability to predict therapeutic response to abiraterone in castration resistant patients [11]	Clinical Trial 50 patients	Fifty patients received either docetaxel (n = 24) or abiraterone (n = 26) therapy, with therapy response rates of 54% and 48%, respectively. In the abiraterone treated cohort, the biomarkers provided information on therapy outcome, demonstrating an association between detectable biomarkers and short progression free survival (PFS) (FOLH1, P < 0.01; KLK3, P < 0.05; and NPY, P < 0.05). Patients with biomarker-negative platelets had the best outcome, while FOLH1 (P < 0.05) and NPY (P = 0.05) biomarkers provided independent predictive information in a multivariate analysis regarding PFS. KLK2 (P < 0.01), KLK3 (P < 0.001), and FOLH1 (P < 0.05) biomarkers were associated with short overall survival (OS). Combining three biomarkers in a panel (KLK3, FOLH1, and NPY) made it possible to separate long-term responders from short-term responders with 87% sensitivity and 82% specificity. Analyzing tumor-derived biomarkers in platelets of CRPC patients enabled prediction of the outcome after abiraterone therapy with higher accuracy than baseline serum PSA or PSA response.
Benzoxazinoids in Prostate Cancer Patients after a Rye-Intensive Diet: Methods and Initial Results [12]	Pilot Study 10 patients	The biopsies exhibited concentrations above the detection limit of seven benzoxazinoids ranging from 0.15 to 10.59 ng/g tissue. An OPLS-DA analysis on histological and plasma concentrations of benzoxazinoids classified the subjects into two clusters. A tendency of higher benzoxazinoid concentrations toward the benign group encourages further investigations. Benzoxazinoids were quantified by an optimized LC-MS/MS method, and matrix effects were evaluated. At low concentrations in biopsy and plasma matrices the matrix effect was concentration-dependent and nonlinear. For the urine samples the general matrix effects were small but patient-dependent.
Detection and dynamics of circulating tumor cells in patients with high-risk prostate cancer treated with radiotherapy and hormones: a prospective phase II study. [13]	Prospective analysis 65 patients	CTCs were detected in 5/65 patients (7.5%) at diagnosis, 8/62 (12.9%) following neoadjuvant androgen deprivation and 11/59 (18.6%) at the end of radiotherapy, with a median CTC count/7.5 ml of 1 (range, 1-136). However, when we analyzed variations in CTC patterns following treatmen we observed a significant association between conversion of CTCs and stages T3 (P = 0.044) and N1 (P = 0.002). Detection of CTCs was not significantly associated with overall survival (P > 0.40). Study showed a low detection rate for CTCs in patients with locally advanced high-risk prostate cancer. The finding of a de novo positive CTC count after androgen deprivation therapy is probably due to a passive mechanism associated with the destruction of the tumor. Further studies with larger samples and based on more accurate detection of CTCs are needed to determine the potential prognostic and therapeutic value of this approach in non-metastatic prostate cancer

TABLE 2 (Continued)

Finasteride concentrations and prostate cancer risk: results from the Prostate Cancer Prevention Trial [9]	Case-Control Study Data for this nested case-control study are from the PCPT	Among men with detectable finasteride concentrations, there was no association between finasteride concentrations and prostate cancer risk, low-grade or high-grade, when finasteride concentration was analyzed as a continuous variable or categorized by cutoff points. Since there was no concentration-dependent effect on prostate cancer, any exposure to finasteride intake may reduce prostate cancer risk. Of the twenty-seven SNPs assessed in the enzyme target and metabolism pathway, five SNPs in two genes, CYP3A4 (rs2242480; rs4646437; rs4986910), and CYP3A5 (rs15524; rs776746) were significantly associated with modifying finasteride concentrations. These results suggest that finasteride exposure may reduce prostate cancer risk and finasteride concentrations are affected by genetic variations in genes responsible for altering its metabolism pathway
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Platelets harbor prostate cancer biomarkers and the ability to predict therapeutic response to abiraterone in castration resistant patients [11]	Clinical Trial 50 patients	Fifty patients received either docetaxel (n = 24) or abiraterone (n = 26) therapy, with therapy response rates of 54% and 48%, respectively. Transcripts for the PC-associated biomarkers kallikrein-related peptidase-2 and -3 (KLK2, KLK3), folate hydrolase 1 (FOLH1), and neuropeptide-Y (NPY) were uniquely present within the platelet fraction of cancer patients and not detected in healthy controls (n = 15). In the abiraterone treated cohort, the biomarkers provided information on therapy outcome, demonstrating an association between detectable biomarkers and short progression free survival (PFS) (FOLH1, $P < 0.01$; KLK3, $P < 0.05$; and NPY, $P < 0.05$). Patients with biomarker-negative platelets had the best outcome, while FOLH1 ($P < 0.05$) and NPY ($P = 0.05$) biomarkers provided independent predictive information in a multivariate analysis regarding PFS. KLK2 ($P < 0.01$), KLK3 ($P < 0.001$), and FOLH1 ($P < 0.05$) biomarkers were associated with short overall survival (OS). Combining three biomarkers in a panel (KLK3, FOLH1, and NPY) made it possible to separate long-term responders from short-term responders with 87% sensitivity and 82% specificity.
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TABLE 2 (Continued)

TP53 Outperforms Other Androgen Receptor Bio markers to Predict Abiraterone or Enzalutamide Outcome in Meta static Castration-Resistant Prostate Cancer [14]	A cohort study. 168 patients	Overall, no single AR perturbation remained associated with adverse prognosis after multivariable analysis. Instead, tumor burden estimates (CTC counts, ctDNA fraction, and visceral metastases) were significantly associated with PFS. TP53 inactivation harbored independent prognostic value [HR 1.88; 95% confidence interval (CI), 1.18-3.00; P = 0.008], and outperformed ARV expression and detection of genomic AR alterations. Using Cox coefficient analysis of clinical parameters and TP53 status, we identified three prognostic groups with differing PFS estimates (median, 14.7 vs. 7.51 vs. 2.62 months; P < 0.0001), which was validated in an independent mCRPC cohort (n = 202) starting first-line ARSi (median, 14.3 vs. 6.39 vs. 2.23 months; P < 0.0001).
External beam radiation therapy and abiraterone in men with localized prostate cancer: safety and effect on tissue androgens[15] Weekly cabazitaxel plus prednisone is effective and less toxic for 'unfit' metastatic castration-resistant prostate cancer: Phase II Spanish Oncology Genitourinary Group (SOGUG) trial[16]	A prospective, phase 2 study Circulating tumour cells (CTCs) were also collected. New treatment scheme was considered effective if at least 65% of patients met a clinical benefit criterion based on prostate-specific antigen (PSA)-progression - free survival (PFS) values at week 12	In an all-comer cohort, tumor burden estimates and TP53 outperform any AR perturbation to infer prognosis A total of 22 men with intermediate- (n=3) and high-risk PCa (n=19) received study therapy. Sixteen men completed the intended course of abiraterone, and 19 men completed planned radiation to 77.4 to 81 Gy. Radiation to pelvic nodes was administered in 20 men. The following grade 3 toxicities were reported: lymphopenia (14 patients), fatigue (1 patient), transaminitis (2 patients), hypertension (2 patients), and hypokalemia (1 patient). There were no grade 4 toxicities. All 21 men who complied with at least 3 months of abiraterone therapy had a preradiation prostate-specific antigen (PSA) concentration nadir of <0.3 ng/mL. Median levels of tissue androgen downstream of CYP17A were significantly suppressed after treatment with abiraterone, and upstream steroids were increased. At median follow-up of 21 months (range: 3-37 months), only 1 patient (who had discontinued abiraterone at 3 months) had biochemical relapse. Addition of abiraterone to LHRHa with radiation is safe and achieves effective prostatic androgen suppression. Preliminary analysis of the clinical data is also promising, with excellent PSA nadir and no relapse to date in this high-risk population.Seventy patients (median age: 73.9 years) were enrolled; overall, 71.4% had an Eastern Cooperative Oncology Group Performance Status (ECOG-PS) of 2; and 84%, 16% and 11% had bone, liver and lung metastases, respectively. Objective partial response or stable disease was achieved in 61% of patients, while PSA responses of ≥50% and ≥80% were observed in 34.8% and 10.6%, respectively. The median PSA-PFS was 4.8 months; and 68.6% of patients had no progression at week 12. The most frequent grade 3/4 toxicities were neutropenia (2.8%), leukopenia (5.7%) and thrombocytopaenia (9%); no cases of febrile neutropenia were reported. Early CTC response was significantly correlated with PSA-PFS. CBZ/prednisone administered weekly to 'unfit' mCRPC patients appears to be as effective as classical standard 3-week scheme (TROPIC study) but with significantly lower toxicities and better tolerance. Early CTC response appears to be valuable as an early endpoint of therapeutic efficacy

III. RESULTS

TABLE 1 shows the clinical studies using Liquid Biopsy for Prostatic Cancer. Annala et al. [6] found that relative impact of common circulating tumor DNA alterations on patient response to the most widely used large, randomize advanced prostate cancer. Our findings suggest that liquid biopsy analysis can guide the use of AR-targeted therapy in general practice. Haldrup et al. [7] reported that ZNF660 methylation analysis can potentially help to stratify low-/intermediate-grade PCs into indolent vs. more aggressive subtypes. Chadid et al. [8] found that common circulating carotenoids and retinol are not useful dietary intervention targets for preventing prostate cancer via modulating intraprostatic inflammation. Chau et al. [9] found that finasteride exposure may reduce prostate cancer risk and finasteride concentrations are affected by genetic variations in genes responsible for altering its metabolism pathway. Efstathiou et al. [10] reported that AR subcellular localization shift from the nucleus was confirmed in eight paired samples (with PSA decline) of 23 evaluable paired samples. The presence of an ARV7 variant was associated with primary resistance to enzalutamide (p = 0.018). Tjon-Kon-Fat et al. [11] found that tumor-derived biomarkers in platelets of CRPC patients enabled prediction of the outcome after abiraterone therapy with higher accuracy than baseline serum PSA or PSA response. Steffensen et al. [12] found that Benzoxazinoids

were quantified by an optimized LC-MS/MS method, and matrix effects were evaluated. At low concentrations in biopsy and plasma matrices the matrix effect was concentration-dependent and nonlinear. For the urine samples the general matrix effects were small but patient dependent. Zapatero et al. [13] reported that de novo positive CTC count after androgen deprivation therapy is probably due to a passive mechanism associated with the destruction of the tumor. Further studies with larger samples and based on more accurate detection of CTCs are needed to determine the potential prognostic and therapeutic value of this approach in non-metastatic prostate cancer. De Laere et al. [14] reported that in an all-comer cohort, tumor burden estimates and TP53 outperform any AR perturbation to infer prognosis. Cho et al. [15] reported that Addition of abiraterone to LHRHa with radiation is safe and achieves effective prostatic androgen suppression. Preliminary analysis of the clinical data is also promising, with excellent PSA nadir and no relapse to date in this high-risk population. Climent et al. [16] found that CBZ/prednisone administered weekly to 'unfit' mCRPC patients appears to be as effective as classical standard 3-week scheme (TROPIC study) but with significantly lower toxicities and better tolerance. Early CTC response appears to be valuable as an early endpoint of therapeutic efficacy

V. CONCLUSION

Liquid biopsies can identify CTCs associated with many cancers. Having fewer tumor cells is associated with a better outcome than having many tumor cells. Your healthcare provider can perform periodic tests to monitor your condition and adjust treatment as needed. Liquid biopsies can show if you're a good candidate for certain types of targeted therapy treatments. Targeted therapy is a type of cancer treatment designed to destroy certain types of cancer cells. For example, a cancer cell may have an error in its DNA that a specific targeted therapy is designed to attack. A liquid biopsy can detect these errors. In turn, your healthcare provider may prescribe a treatment that targets that error. Prostate cancer is one of the most common types of cancer. Many prostate cancers grow slowly and are confined to the prostate gland, where they may not cause serious harm.
However, while some types of prostate cancer grow slowly and may need minimal or even no treatment, other types are aggressive and can spread quickly.
In determining a PC patient's diagnosis, prognosis, and response to treatment, liquid biopsy is very valuable.
liquid biopsy is very valuable. clinically useful targets in PC. In conclusion, liquid biopsies have Characterizing the components of liquid biopsies helps to identify underlying resistance mechanisms and to use new enormous potential to advance clinical oncology care despite still having significant drawbacks. This kind of biopsy, in particular, presents prospects to enhance the monitoring of cancer patients during therapy and could soon be a useful addition to current tumor profiling and diagnosis methods.

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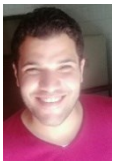

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