

Effect of PSMA PET/CT on the Use of Bone Scintigraphy for Prostate Cancer at a University Hospital System

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We observed at our university-based imaging centers that when prostate-specific membrane antigen (PSMA) PET/CT became available for staging and restaging prostate cancer, the volume of bone scanning on patients with prostate cancer (BS-P) markedly decreased. We aimed to study use patterns of PSMA PET/CT and BS-P at our imaging centers during the 4-y period around U.S. Food and Drug Administration approval of PSMA PET/CT in December 2020. We tested the hypothesis that the rate of decline of BS-P accelerated after U.S. Food and Drug Administration approval, as physicians planned for use of PSMA PET/CT in their patients.

Methods: Our clinical report system was searched for BS-P and PSMA PET/CT scans from January 2019 through June 2023. Numbers of scans were tabulated by quarter and year. Quantitative and statistical analyses were performed. **Results:** Annualized average monthly BS-P peaked at 53.7 scans/mo in 2021 and then decreased over time. There were 552 BS-Ps performed in 2019, 503 in 2020, 614 in 2021, 481 in 2022, and 152 in the first half of 2023. BS-P monthly averages declined by 22% from 2021 to 2022 and by 36% from 2022 to 2023, whereas monthly PSMA PET/CT scan averages increased by 1,416% from 2021 to 2022 and by 69% from 2022 to 2023. There was a significantly greater decline in BS-Ps from 2022 to 2023 than from 2021 to 2022 (36% vs. 22%, $P < 0.0001$). There were 30 PSMA PET/CT scans performed in 2021, 455 in 2022, and 384 in the first half of 2023. The greatest quarterly increase in these scans (400%) occurred at the outset of PSMA PET/CT implementation in quarter 4 of 2021. In quarter 2 of 2023, the percentage of total studies was higher for PSMA PET/CT than for BS-P (74% vs. 26%, $P < 0.0001$). **Conclusion:** At our university-based imaging centers, use of BS-P has declined in correlation with the timing of U.S. Food and Drug Administration approval and implementation of PSMA PET/CT. This study illustrates one instance of workflow changes that occur in the nuclear medicine clinic when new agents are introduced and affect clinical management options.

Key Words: bone scan; PSMA PET/CT; utilization; clinic management

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Introduction of new radiopharmaceuticals can cause changes in clinical practice patterns that substantially affect workflow in the nuclear medicine clinic. Management of

the nuclear medicine clinic includes many domains, including patient experience and satisfaction, scan preparation and instruction, physician ordering, scheduling, billing and preauthorization, facility design and planning, equipment procurement and use, radiopharmaceutical ordering, technologist and physician staffing, budget expectations, forecast and analysis, and workload distribution within the health care system. When clinical practice patterns associated with imaging studies change, nuclear medicine clinical managers must address many of these logistic components, often simultaneously.

In 2023, prostate cancer accounted for 29% of all cancer diagnoses in men in the United States, with new cases numbering approximately 290,000 annually. A recent analysis from 2014 to 2019 showed a 3% per year increase in prostate cancer incidence in the United States during that time (1). This large patient population requires clinical imaging for initial staging, restaging, and surveillance. In previous years, the reference standard of prostate cancer staging has included conventional imaging with whole-body bone scanning (BS-P), CT, and MRI (2). However, with the U.S. Food and Drug Administration approval of prostate-specific membrane antigen (PSMA)-targeting PET radiopharmaceuticals in 2020, the use of PSMA PET/CT for prostate cancer has increased as studies have shown its clinical usefulness and advantages over previous methods of clinical staging (2).

For the nuclear medicine clinic, the implications of this change in practice patterns include reduced numbers of whole-body BS-Ps and increased numbers of PSMA PET/CT examinations, affecting several areas of workflow management in the nuclear medicine clinic. However, the magnitude of change in numbers of these scans for prostate cancer over time has not been evaluated in the medical literature. The purpose of our study was to investigate the trend of BS-P versus PSMA PET/CT at a major university hospital system in the United States in the first years after its approval by the U.S. Food and Drug Administration.

MATERIALS AND METHODS

Patient Population

Our Institutional Review Board determined that this clinical use analysis project did not meet the definition of human subject research and that approval was not required. Our university-based

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imaging center's clinical system was searched for PSMA PET/CT and BS-P scans from January 2019 through June 2023. Numbers of BS-P and PSMA PET/CT scans were tabulated by month, quarter, and year. Initial U.S. Food and Drug Administration approval of PSMA PET/CT occurred in December 2020. Clinical implementation at our imaging centers occurred during quarter 3 of 2021.

BS-P Protocol

A standard bone scanning protocol was followed for the evaluation of prostate cancer (3). All patients were instructed to hydrate and to void their urinary bladder before imaging. Approximately 3 h after administration of 740 MBq (20 mCi) of ^{99m}Tc-hydroxymethylene diphosphonate intravenously, whole-body anterior and posterior planar images were acquired from vertex to toes with the patient supine. After review by a nuclear medicine physician, additional planar static or SPECT/CT images were obtained if deemed necessary for interpretation.

PSMA PET/CT Protocol

A standard PET/CT imaging protocol was followed for the evaluation of prostate cancer (4). All patients were instructed to hydrate and to empty their urinary bladder before imaging.

Patients were not instructed to discontinue androgen-deprivation therapy before PSMA PET/CT. Approximately 60 min after administration of 333 MBq (9.0 mCi) of ¹⁸F-piflufolastat or 185 MBq (5.0 mCi) of ⁶⁸Ga-gozetotide through right-upper-extremity intravenous access, patients were positioned on the PET/CT scanner supine with their arms up. CT was performed from vertex to knees, followed by PET of the same area in the caudocranial direction. PET images were reconstructed with attenuation correction using CT and then fused.

Statistical Analysis

Statistical analysis was performed using MedCalc Statistical Software (version 20.218; MedCalc Software Ltd.). Values are reported as the mean ± SD. Proportions were compared using the χ^2 test. Numbers of cases for each year were annualized per month to enable comparison of scan proportions in the first 6 mo of 2023 to 12-mo case numbers from years 2019–2022. A *P* value of less than 0.05 was considered statistically significant.

RESULTS

The numbers of BS-P and PSMA PET/CT scans performed each quarter through quarter 2 of 2023 are shown graphically in Figure 1.

Annualized average monthly BS-Ps peaked at 53.7 cases/mo in 2021 and then decreased progressively over time (Table 1). There were 552 BS-Ps performed in 2019, 503 in 2020, 614 in 2021, 481 in 2022, and 152 in the first half of 2023. BS-P monthly averages declined by 22% from 2021 to 2022 and by 36% from 2022 to 2023. There was a significantly greater decline in BS-P cases from 2022 to 2023 than from 2021 to 2022 (36% vs. 22%, *P* < 0.0001).

There were 30 PSMA PET/CT scans in 2021, 455 in 2022, and 384 in the first half of 2023. PSMA PET/CT monthly case averages increased by 1,416% from 2021 to 2022 and by 69% from 2022 to 2023 (Table 1). The highest quarterly increase in PSMA PET/CT (400%) occurred at

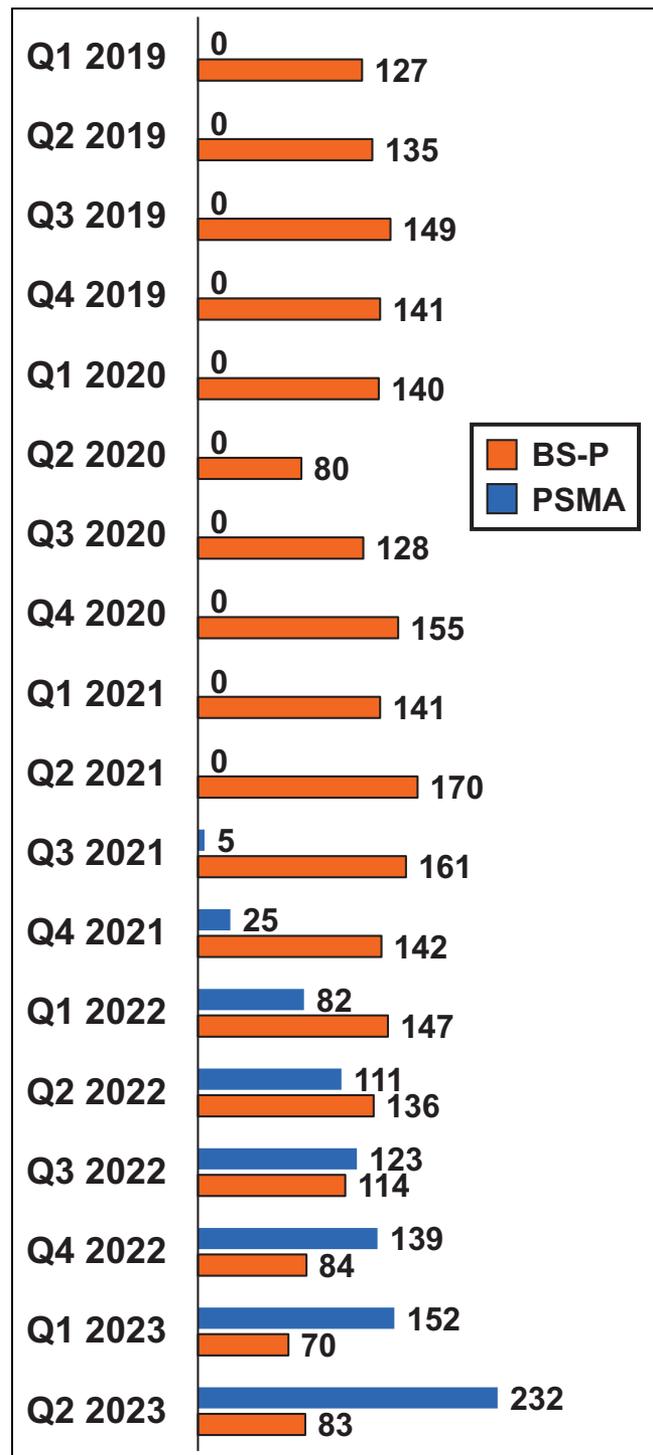


FIGURE 1. BS-P and PSMA PET/CT prostate cancer studies. Q1–Q4 = quarters 1–4.

the outset of PSMA PET/CT implementation in quarter 4 of 2021.

The number of BS-Ps declined as PSMA PET/CTs increased, a trend that continued into quarter 2 of 2023, at which time the percentage of total studies was higher for PSMA PET/CT than for BS-P (74% vs. 26%, *P* < 0.0001) (Fig. 2).

TABLE 1
BS-P and PSMA PET/CT Case Numbers and Monthly Averages by Year

Parameter	2019	2020	2021	2022	2023*
BS-P plus PSMA PET/CT					
All cases	552	503	644	936	536
Monthly average	46.0	41.9	53.7	78.0	89.5
BS-P					
Monthly average	46.0	41.9	51.2	40.1	25.5
Change in monthly average	—	−9%	+22%	−22%	−36%
PSMA PET/CT					
Monthly average	0.0	0.0	2.5	37.9	64.0
Change in monthly average	—	—	—	+1,416%	+69%

*Quarters 1–2

DISCUSSION

Since the approval and implementation of PSMA PET/CT at our imaging centers, there has been a progressive decline in whole-body BS-P performed for staging and restaging. PSMA PET/CT was first introduced during quarter 3 of 2021, ending with a total of 30 scans in quarters 3 and 4. PSMA PET/CT use increased each quarter, resulting in 455 scans in 2022. The highest number of PSMA PET/CT scans in any quarter was 232 in quarter 2 of 2023, demonstrating a progressive increase in use.

The progressive decline in BS-P and increase in PSMA PET/CT at our imaging centers is likely multifactorial. PSMA PET/CT has a higher sensitivity and specificity for detecting prostate cancer metastases, making it a highly effective staging modality (5,6). Evidence-based data demonstrate that whole-body BS-P is inferior to PSMA PET/CT in terms of diagnostic accuracy for detecting prostate cancer bone metastases. Furthermore, PSMA PET/CT potentially provides significant changes in clinical management compared with BS-P for several reasons, including detection of bone metastases in patients with negative BS-P findings, identification of more bone metastases than with BS-P, reduction in the number of false-positive findings compared with BS-P, and detection of soft-tissue metastases such as lymphadenopathy (2).

With changes in use of different modalities within nuclear medicine, there are numerous implications for imaging centers and their managers. For patients undergoing PSMA PET/CT, improvements in experience and satisfaction may be seen. For example, time required from injection to completion of imaging is often 4 h for BS-P and less than 2 h for PSMA PET/CT. Order sets, scheduling, and preauthorization operating procedures need to be created when necessary and then implemented and optimized. Radiopharmaceutical supply and purchasing contracts need to be analyzed and negotiated. Facility design parameters need to be assessed and potentially updated to reflect the higher volume of PSMA PET/CT cases and the lower volume of BS-P cases. Technologist and physician staffing needs to be flexed toward more PET/CT coverage. Yearly budget projections need to reflect higher radiopharmaceutical costs and increased reimbursement for PET/CT compared with BS-P. Within health care systems, imaging sites with PET/CT could see a shift toward higher patient volumes, and sites that perform only BS-P could see lower volumes.

This study had some limitations. For example, the study evaluated imaging orders at only specific sites over the study time period. The study was unable to determine whether patients were referred to different imaging sites or health care organizations. Also, whether some patients had both BS-P and PSMA PET during the study period could not be determined. The clinical indication for the studies ordered was limited to prostate cancer, and more specific clinical indications (e.g., response to therapy or indeterminate prior study) were not evaluated. In addition, the study represented one institution’s experience. Other centers may have different experiences based on referring provider preferences and practice patterns, level of health care industry marketing to referring physicians, availability of types of scans, and patient participation in research protocols.

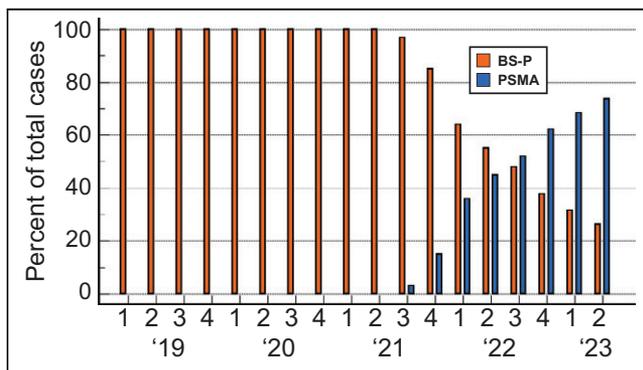


FIGURE 2. Percentage of total cases for BS-P and PSMA PET/CT by quarter.

CONCLUSION

At our university-based imaging centers, use of BS-P has declined in correlation with the timing of U.S. Food and Drug Administration approval and implementation of PSMA

PET/CT for patients with prostate cancer. This study illustrates one instance of workflow changes that occur in the nuclear medicine clinic when new agents are introduced and affect clinical management options.

KEY POINTS

QUESTION: To what extent did use of BS-P decrease after introduction of PSMA PET/CT at a university hospital system?

PERTINENT FINDINGS: After implementation of PSMA PET/CT, there was a progressive decline in BS-P that coincided with increasing use of PSMA PET/CT.

IMPLICATIONS FOR PATIENT CARE: Marked changes in use of different modalities in nuclear medicine can affect clinical workflow, management, and patient experience.

DISCLOSURE

No potential conflict of interest relevant to this article was reported.

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