Evaluation of four pre-operative models for prediction of biochemical recurrence after radical prostatectomy in localized prostate cancer

Musab Kutluhan[1], Selman Ünal[1], Emrah Özsoy[2], Aytaç Şahin[3], Asim Ozayar[1], Emrah Okulu[1], and önder kayıgil[1]

[1]Yildirim Beyazit University
[2]Ünye State Hospital
[3]Health Sciences University, Fatih Sultan Mehmet Training and Research Hospital

June 30, 2021

Abstract

Background: Biochemical recurrence (BCR) can be seen in the early or late period after radical prostatectomy (RP). Various models have been developed to predict BCR. Objective: In our study we evaluated accuracy of four pre-operative models (GP score, PRIX, D'Amico risk classification, CAPRA) in predicting BCR after RP in Turkish patients. Methods: Age, preoperative total prostate specific antigen (PSA) values, clinical stages, total number of cores taken in biopsy, number of positive cores, preoperative biopsy Gleason score (GS), follow-up time and presence of BCR after RP were recorded. BCR was defined as a total PSA value $>$ 0.2 ng / dl twice consecutively after RP. Classifications or scoring was performed according to pre-operative models. The 1, 3 and 5 year (yr) BCR-free rates of the patients were determined for each model. Also the accuracy of four predictive models for predicting 1, 3 and 5-yr BCR was evaluated. Results: For all pre-operative models there was statistically significant difference between risk groups in BCR free rates at 1, 3 and 5-yr after RP ($p<0.001$). The Harrell's concordance index for 1-yr BCR predictions was 0,802, 0,831, 0,773 and 0,745 for the GP score, PRIX, CAPRA and D'Amico and respectively. For 3-yr BCR predictions it was 0,798, 0,791, 0,723 and 0,714 for the GP score, PRIX, CAPRA and D'Amico and respectively. Finally, The Harrell's concordance index for 5-yr BCR predictions was 0,778, 0,771, 0,702 and 0,693 for the GP score, PRIX, CAPRA and D'Amico and respectively. Conclusion: In prediction of BCR, accuracy of GP scoring and PRIX seems slightly higher than CAPRA and D'Amico risk classification. Surely our results should be supported by head to head comparisons with in other larger cohorts

Title: Evaluation of four pre-operative models for prediction of biochemical recurrence after radical prostatectomy in localized prostate cancer

Abstract

Background: Biochemical recurrence (BCR) can be seen in the early or late period after radical prostatectomy (RP). Various models have been developed to predict BCR.

Objective: In our study we evaluated accuracy of four pre-operative models (GP score, PRIX, D'Amico risk classification, CAPRA) in predicting BCR after RP in Turkish patients.

Methods: Age, preoperative total prostate specific antigen (PSA) values, clinical stages, total number of cores taken in biopsy, number of positive cores, preoperative biopsy Gleason score (GS), follow-up time and presence of BCR after RP were recorded. BCR was defined as a total PSA value $>$ 0.2 ng / dl twice consecutively after RP. Classifications or scoring was performed according to pre-operative models. The 1,

3 and 5 year (yr) BCR-free rates of the patients were determined for each model. Also the accuracy of four predictive models for predicting 1, 3 and 5-yr BCR was evaluated.

Results: For all pre-operative models there was statistically significant difference between risk groups in BCR free rates at 1, 3 and 5-yr after RP ($p<0.001$). The Harrell's concordance index for 1-yr BCR predictions was 0,802, 0,831, 0,773 and 0,745 for the GP score, PRIX, CAPRA and D'Amico and respectively. For 3-yr BCR predictions it was 0,798, 0,791, 0,723 and 0,714 for the GP score, PRIX, CAPRA and D'Amico and respectively. Finally, The Harrell's concordance index for 5-yr BCR predictions was 0,778, 0,771, 0,702 and 0,693 for the GP score, PRIX, CAPRA and D'Amico and respectively.

Conclusion: In prediction of BCR, accuracy of GP scoring and PRIX seems slightly higher than CAPRA and D'Amico risk classification. Surely our results should be supported by head to head comparisons with in other larger cohorts

Keywords: Prostate cancer, preoperative predictive models, radical prostatectomy, biochemical recurrence

What's known

- Biochemical recurrence can be seen in the early or late period after radical prostatectomy.
- Pre-operative models are used in prediction of biochemical recurrence
- D'Amico risk classification and CAPRA scoring are widely used well performed predictive models.

What's new

- GP score and PRIX are relatively new models
- There is not so much study that indicates performance of these models especially for GP score.
- There is no study in literature that compares them with other well-known models.
- Accuracy of GP score and PRIX in prediction of biochemical recurrence is comparable with other well-known models.

INTRODUCTION

Prostate cancer (PCa) is the second most common cancer in men[1]. Today, the gold standard treatment for localized prostate cancer is radical prostatectomy. Biochemical recurrence (BCR) can be seen in the early or late period after RP. BCR is an important condition in patients who have undergone radical prostatectomy as it indicates that clinical recurrence may also occur. Characteristics of patients such as prostate biopsy Gleason score (GS), clinical stage, preoperative total prostate specific antigen (PSA) value may differ. Various models have been developed using these pre-operative characteristics to predict BCR [2].

In clinical practice, the D'Amico risk classification and the Cancer of prostate risk assessment (CAPRA) are frequently used models to predict BCR. In D'Amico risk classification, pre-operative total PSA, clinical stage and prostate biopsy GS score are used [3]. In addition to these parameters, in CAPRA scoring, patient age and positive core ratio are also used [4]. On the other hand, in addition to frequently used models, models that are relatively less used in clinical practice have been defined. Yoshida et al. defined The prostate cancer risk index (PRIX) [5]. In addition, the external validation of the PRIX scoring has been performed[6]. Soga et al. defined The GP Score, a Simplified Formula (Bioptic Gleason Score Times Prostate Specific Antigen) and demonstrated that it could predict BCR after RP [7].

The models used to predict BCR after RP have been compared. D'Amico risk classification, CAPRA scoring and Stephenson nomogram, which are frequently used in clinical practice, were compared in the same patient group [8]. Although there is studies that indicate predictive values of GP and PRIX score in BCR, to best our knowledge there is no head to head comparison of GP score and PRIX score with other well-known models in predicting BCR. These models are relatively new and use of GP score is easier than other prediction models. It was known that predictions of BCR can be varied between pre-operative models. So in our study we evaluated accuracy of four pre-operative models (GP score, PRIX, D'Amico risk classification, CAPRA) in predicting BCR after RP in Turkish patients.

MATERIAL AND METHOD

Patient selection and study design

After local ethic committee approval (26379996/49), 259 patients from 3 different hospitals who were diagnosed with localized prostate cancer and underwent radical prostatectomy were included in our study. Age, preoperative total PSA values, clinical stages, total number of cores taken in biopsy, number of positive cores, preoperative biopsy GS, follow-up time and presence of BCR after RP were recorded. PCa diagnosis was made by trans rectal-ultrasonography-guided prostate biopsy. Patients with a total PSA value$>$ 2.5 in two consecutive measurements and / or with suspicious nodules on digital rectal examination (DRE) had prostate biopsy. Pathology results were evaluated by 3 different dedicated uropathologists. American Joint Committee on Cancer Tumor (T) node (N) metastasis (M) classification was used for assignment of clinical stage [9]. Multiparametric MRI (mpMRI) was not used in clinical staging. Post-operative nadir PSA was evaluated in 4-6 week. Afterwards, the total PSA was evaluated every 3 months for the first two years and then every 6 months for up to 5 years. BCR was defined as a total PSA value $>$ 0.2 ng / dl twice consecutively after RP.

Inclusion and exclusion criteria

Patients who were diagnosed with localized (cT1-T2) PCa, had RP operation and were followed up regularly for BCR were included in our study. Patients diagnosed with metastatic or locally advanced PCa, patients with positive surgical margins, patients with pathological lymph node metastasis, patients receiving neo-adjuvant hormonotherapy or radio-chemotherapy, patients receiving adjuvant therapy after RP, patients who had nadir PSA above 0.2 ng/dl after RP, patients without regular follow-up were not included in the study.

D'Amico risk classification

D'Amico risk classification was performed according to the preoperative total PSA value, prostate biopsy GS and clinical T stages. According to this classification, patients were divided into 3 groups as low risk, intermediate risk and high risk. Patients with preoperative total PSA $<$10 ng / dl, GS $<$7 and clinical stage cT1-2a were considered low-risk group. Patients with total PSA 10-20 ng / dl or GS 7 or clinical stage cT2b were defined as intermediate-risk group. Lastly, patients with total PSA value$>$ 20 ng / dl or GS$>$ 7 or clinical stage cT2c were identified as the high-risk group [3].

CAPRA scoring

According to the CAPRA scoring, patients were divided into 3 groups as low, intermediate and high risk. Scoring was done according to preoperative total PSA value, GS pattern, clinical T stage, percentage of positive biopsy cores and age [10]. Accordingly, the total PSA value between 2.1-6 ng / dl was given 0 point, 6.1-10 ng / dl 1 point, 10.1-20 ng / dl 2 points, 20.1-30 ng / dl 3 points and above 30 ng / dl. 4 points. A score of 0 was given to the patient with no GS pattern, 1 point to the patient with a seconder GS pattern of 4 or 5, and 2 points to the patient with a primary GS pattern of 4 or 5. The patient with clinical T stage 1-2 was given a score of 0 and to the patient with 3a 1 point. A score of 0 was given to the patient whose positive core percentage was below 34, and 1 point to the patient with a higher core percentage. Lastly, a score of 0 was given to patients under the age of 50 and 1 point to patients over the age of 50. 0-2 points were defined as low risk, 3-5 points as intermediate risk, and 6 and above points as high risk.

PRIX Scoring

PRIX scoring was performed according to preoperative total PSA level, prostate biopsy GS and clinical stage according to the definition of Yoshida T et al [6]. Accordingly, patients with a total PSA value of less than 10 ng / dl were given 0 points, patients between 10-20 ng / dl 1 point, and patients with 20 mg / dl above 2 points. A score of 0 was given to patients with GS 6, 1 point to patients with 7, and 2 points to patients with a score of 8 and above. Patients with clinical stage T1-T2a were given 0 points, patients with T2b-T2c 1 point, and patients with T3-4 2 points. A total of 3 scores was defined as the PRIX score. The patients

were divided into 4 groups according to their PRIX scores: with a score of 0, a score of 1, a score of 2, and a score of 3 or more.

GP Scoring

GP score was obtained by multiplying the preoperative total PSA value with the prostate biopsy GS according to the definition of Soga N et al[7]. According to the distribution of scores, patients were divided into 3 groups as low, intermediate and high risk (<50, 50-100, >100).

After the patients were divided into risk groups with each predictive model, the 1, 3 and 5 year (yr) BCR-free rates of the patients were determined for each model. Also the accuracy of four predictive models for predicting 1, 3 and 5-yr BCR was evaluated.

Statistical evaluation

Statistical analyses were performed via S-PLUS Professional and R statistics v.1 (MathSoft, Seattle, WA, USA). The descriptive characteristics of the variables are summarized by mean, median, frequency and percentage. Kaplan-Meier survival analyses and log rank test were done to estimate BCR-free rates of all classifications and compare them. The accuracy of the four prognostic models for prediction of BCR was quantified according to Harrell's concordance index[11,12]. Harrell's concordance index provides the probability that, in a randomly selected pair of patients in which one patient experiences the event (BCR) before the other, the patient who experiences the event had the worse predicted outcome according to the predictive model. In accuracy analyses, a value of 100% indicates perfect prediction versus 50% being equivalent to a toss of a coin. In our study, the accuracy value of four prognostic models were calculated according to Harrell's concordance index. 0.05 was considered as the significance threshold for p-value.

RESULTS

All patients were Turkish. The mean age of the patients included in our study was 63.89 ± 6.08. The median follow-up period of the patients was 60.0 (6.0-148.0) months. Median BCR time was 12.0 (3.0-48.0) months. The clinical characteristics of the patients are summarized in table 1. Patient distribution according to risk groups of predictive models was indicated in table 2.

Overall BCR free rates at 1, 3 and 5-yr after RP was 89%, 77,9% and 75,8% respectively (Figure 1). According to D'Amico risk classification there was statistically significant difference between risk groups in BCR free rates at 1, 3 and 5-yr after RP ($p<0.001$). According to CAPRA score categories BCR free rates at 3-yr after RP was 93.9%, 64.5% and 37.5% for low, intermediate and high risk groups respectively. There was statistically significant difference between risk groups in BCR free rates at 1, 3 and 5-yr after RP ($p<0.001$). In addition, there was statistically significant difference between risk groups of GP score in BCR free rates at 1, 3 and 5-yr after RP ($p<0.001$). For PRIX we combined patients with a score of 3, 4 and 5 because there were few patients with these scores. There was statistically significant difference between score groups of PRIX score in BCR free rates at 1, 3 and 5-yr after RP ($p<0.001$) (Figure 2).

In our study, the accuracy of four prognostic models were calculated according to Harrell's concordance index. The Harrell's concordance index for 1-yr BCR predictions was 0,802, 0,831, 0,773 and 0,745 for the GP score, PRIX, CAPRA and D'Amico and respectively. For 3-yr BCR predictions it was 0,798, 0,791, 0,723 and 0,714 for the GP score, PRIX, CAPRA and D'Amico and respectively. Finally, The Harrell's concordance index for 5-yr BCR predictions was 0,778, 0,771, 0,702 and 0,693 for the GP score, PRIX, CAPRA and D'Amico and respectively.

DISCUSSION

Post-RP BCR is a condition that can be encountered in clinical practice due to heterogeneity in prostate cancer. Although RP is the gold standard treatment option for localized PCa, radiotherapy and local ablative treatments are also available, and BCR prediction is important for optimal treatment in patients diagnosed with localized PCa. Occurrence of BCR depends on clinical stage, pre-operative total PSA value and pre-operative prostate biopsy GS [13]. Predictive models for BCR after RP have been developed to date. D'Amico

risk classification and CAPRA scoring are frequently used models[3,4]. To best of our knowledge, there is no study in the literature that compares GP scoring and PRIX scoring which are relatively newly developed and are not frequently used in clinical practice with D'Amico risk classification and CAPRA scoring. In our study, we evaluated these four predictive models in terms of their predictive value of BCR for the first time in Turkish patients.

According to our results Harrell's concordance index results of all predictive models were range from 0,693 to 0,831. It means that all predictive models performed well both in short-term and long-term prediction of BCR. In the study conducted by Lughezzani et al. the Harrell's concordance index for 3-yr BCR predictions was 70.4%, 74.3%, and 75.2% for the D'Amico, CAPRA, and Stephenson models, respectively. Similarly, 5 yr after RP, the Harrell's concordance index of the three BCR predictive models was 67.4%, 72.9%, and 73.5%, respectively[8]. In an another study conducted by Tamblyn et al. the Harrell's concordance index was 0.791 and 0.787 for the Stephenson and CAPRA models respectively [14]. Also, in a study conducted by Yoshida et al indicated that the concordance index of the PRIX score and the D'Amico classification to predict BCR was 0.719 and 0.730, respectively [6]. To best of our knowledge there is no study evaluating concordance index for GP score in literature. In our study the Harrell's concordance index for 3 year BCR predictions was 79,8%, 79,1%, 72,3% and 71,4% for the GP score, PRIX, CAPRA and D'Amico respectively. In addition, the Harrell's concordance index for 5 year BCR predictions was 77,8%, 77,1%, 70,2% and 69,3% for the GP score, PRIX, CAPRA and D'Amico respectively. Our results for D'Amico, CAPRA and PRIX was similar with literature in respect of the Harrell's concordance index for 3-yr and 5-yr BCR predictions. This can indicate us that the Harrell's concordance index for 3-yr and 5-yr BCR predictions of GP score was reliable. In addition, Harrell's concordance index for 3-yr and 5-yr of GP score was slightly higher than D'Amico and CAPRA.

Pre-operative total PSA and GS score which are parameters of GP score are important predictive factors for BCR. In a study conducted by Mithal et al. shown that the greatest improvement in accuracy over the BCR was GS. Specifically, for the outcomes of BCR, c-indices for Gleason score were 0.66 [15]. In addition, Acimovic et al stated that increasing level of preoperative Gleason score, higher level of preoperative PSA and higher percent of positive biopsies were independently associated with occurrence of BCR but clinical stage of disease, number of biopsies and Free/Total PSA ratio did not affect the occurrence of BCR [16]. Literature indicates that for BCR pre-operative total PSA level and GS score are more important factors than others like clinical stage. In our study all predictive models other than GP score use clinical stage in scoring or classification of patient. Although multiparametric MRI (mpMRI) has been increasingly used in clinical practice, digital rectal examination (DRE) is still mostly used tool for clinical staging. In our study we also used DRE in clinical staging of patients. We think that more accurate clinical staging can be performed with mpMRI but its contribution to prediction of BCR is not certain. In a study conducted by Capogrosso et al indicated that the accuracy of the Kattan nomogram (c-index, 0.724) and the D'Amico risk classification (c-index, 0.651) was not significantly improved by adding the mpMRI score (Model 1: c-index, 0.725; Model 2: c-index, 0.674) [17]. On the other hand, Manceau et al defined mpMRI Imaging-Based Risk Classification for recurrence. They concluded that this classification was significantly correlated with the risk of BCR ($p < 0.001$) and the area under curve (AUC) for predicting BCR was 0.714 for the imaging-based classification compared with 0.710 for the D'Amico classification[18]. It is still controversial that routinely available mpMRI information is a potential marker to add to preoperative prediction models to stratify patients'risk and inform treatment planning.

Nonetheless, there are some limitations to this study. Firstly, our study population was not large. Secondly, we couldn't perform decision-curve analyses. Thirdly, our study has short median follow-up. Certainly, longer median follow-up could affect our results. All prostate biopsy pathology reports were not evaluated by same one pathologist. This could result in differences in GS assignment and thought affect score or classifications of predictive models. Lastly, BCR prediction was performed according to pre-operative models. Surely after RP, more precise BCR predictions can be acquired using models that depend on pathologic RP [19].

CONCLUSION

In clinical practice pre-operative models are routinely used before RP for prediction of BCR. Our results demonstrate that all four models performed well. In prediction of BCR, accuracy of GP scoring and PRIX seems slightly higher than CAPRA and D'Amico risk classification. Surely our results should be supported by head to head comparisons with in other larger cohorts.

ACKNOWLEDGEMENTS

None

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

FUNDING

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

ETHICAL APPROVAL

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

REFERENCES

1. Sung H, Ferlay J, Siegel RL et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2021;71(3):209-249
2. Kattan M. Statistical prediction models, artificial neural networks, and the sophism "I am a patient, not a statistic". J Clin Oncol 2002; 20:885–7.
3. D'Amico AV, Whittington R, Malkowicz SB et al. Biochemical outcome after radical prostatectomy, external beam radiation therapy, or interstitial radiation therapy for clinically localized prostate cancer. JAMA 1998; 280:969–974
4. Cooperberg MR, Pasta DJ, Elkin EP, et al. The University of California, San Francisco Cancer of the Prostate Risk Assessment score: a straightforward and reliable preoperative predictor of disease recurrence after radical prostatectomy. J Urol 2005; 173:1938–42
5. Yoshioka Y, Inoue T. Prostate Risk Index (PRIX) as a new method of risk classification for clinically localized prostate cancer. Strahlenther Onkol 2007;183:490–6.
6. Yoshida T, Nakayama M, Matsuzaki K Et al. Validation of the Prostate Cancer Risk Index (PRIX): A Simple Scoring System to Predict Risk of Biochemical Relapse after Radical Prostatectomy for Prostate Cancer Jpn J Clin Oncol 2011;41(11)1271–1276
7. Soga N, Ogura Y, Wakita T, Kageyama T, Furusawa J The GP Score, a Simplified Formula (Bioptic Gleason Score Times Prostate Specific Antigen) as a Predictor for Biochemical Failure after Prostatectomy in Prostate Cancer Curr Urol 2019;13:25–30
8. Lughezzani G, Budaus L, Isbarn H. et al. Head-to-Head Comparison of the Three Most Commonly Used Preoperative Models for Prediction of Biochemical Recurrence After Radical Prostatectomy Eur Urol 2010;57(4):562-8.
9. Brierley JD, et al., TNM classification of malignant tumors. UICC International Union Against Cancer. 8th edn. 2017
10. Meurs P, Galvin R, Fanning DM, Fahey T Prognostic value of the CAPRA clinical prediction rule: a systematic review and meta-analysis BJU Int 2013 Mar;111(3):427-36.
11. Harrell Jr FE, Califf RM, Pryor DB, Lee KL, Rosati RA. Evaluating the yield of medical tests. JAMA 1982;247:2543–6.
12. Harrell Jr FE, Lee KL, Mark DB. Multivariable prognostic models: issues in developing models, evaluating assumptions and adequacy, and measuring and reducing errors. Stat Med 1996;15:361–87.

13. Pak S, Lee DE, You D. et al. Validation of the European association of urology biochemical recurrence risk groups after radical prostatectomy in an Asian cohort and suggestions for refinement Urol Oncol 2021 Feb 9;S1078-1439(20)30653-0. doi: 10.1016/j.urolonc.2020.12.023.
14. Tamblyn DJ, Chopra S, Yu C et al. Comparative analysis of three risk assessment tools in Australian patients with prostate cancer BJU Int 2011;108 (2):51-6.
15. Mithal P, Howard LE, Aronson WJ et al. Prostate-specific antigen level, stage or Gleason score: Which is best for predicting outcomes after radical prostatectomy, and does it vary by the outcome being measured? Results from Shared Equal Access Regional Cancer Hospital database Int J Urol 2015;22(4):362-6.
16. Acimovic M, Stankovic KD, Pejcic T et al. Preoperative Gleason score, percent of positive prostate biopsies and PSA in predicting biochemical recurrence after radical prostatectomy J BUON 2013;18(4):954-60
17. Capogrosso P, Vertosick EA, Benfante NE et al. Can We Improve the Preoperative Prediction of Prostate Cancer Recurrence With Multiparametric MRI? Clin Genitourin Cancer 2019;17(4):e745-e750
18. Manceau C, Beauval JB, Lesourd M et al. MRI Characteristics Accurately Predict Biochemical Recurrence after Radical Prostatectomy J Clin Med 2020 Nov 26;9(12):3841
19. Remmers S, Verbeek JFM, Nieboer D, Kwast van der T, Roobol MJ Predicting biochemical recurrence and prostate cancer-specific mortality after radical prostatectomy: comparison of six prediction models in a cohort of patients with screening- and clinically detected prostate cancer BJU Int 2019;124(4):635-642

Table 1: The clinical characteristics of the patients

Patient number n	259
Mean age Mean±SD	63.89±6.08
Pre-operative Total PSA (ng/dl) n (%)	
0-10	188 (72.6%)
11-20	56 (21.6%)
>20	15 (5.8%)
Clinical stage n (%)	
T1c- T2a	219 (84.6%)
T2b	27 (10.4%)
T2c	13 (5.0%)
Total core number Median (min-max)	12 (6-30)
Positive core percentage Mean	33,77%
Pre-operative biopsy score n (%)	
GS 3+3	186 (71.8%)
GS 3+4	45 (17.3%)
GS 4+3	16 (6.2%)
GS 4+4	8 (3.1%)
GS 3+5	3 (1.2%)
GS 4+5	1 (0.4%)
Biochemical recurrence n(%)	
Yes	52 (20.1%)
No	207 (79.9%)
Follow-up time (month) Median (min-max)	60.0 (6.0-148.0)
BCR time (month) Median (min-max)	12.0 (3.0-48.0)

SD: Standard deviation, PSA: Prostate specific antigen, T: Tumor, GS: Gleason score, BCR: Biochemical recurrence

Table 2: Patient distribution according to risk groups of predictive models

	n	%
D'Amico risk classification		
Low	142	54.8
Intermediate	95	36.7
High	22	8.5
CAPRA score categories		
Low	134	51.7
Intermediate	109	42.1
High	16	6.2
GP score categories		
Low	145	56.4
Intermediate	82	31.9
High	30	11.7
PRIX score categories		
0	133	51.4
1	79	30.5
2	27	10.4
3	11	4.2
4	7	2.7
5	2	0.8

CAPRA: Cancer of prostate risk assessment, GP: Bioptic Gleason Score Times Prostate Specific Antigen, PRIX: The prostate cancer risk index

FIGURE LEGENDS

Figure 1: Overall non-biochemical failure rate

Figure 2: A: BCR free rates according to D'Amico risk classification, **B:** BCR free rates according to CAPRA score categories, **C:** BCR free rates according to GP score categories,**D:** BCR free rates according to PRIX score categories

Hosted file

`Figure 1.docx` available at https://authorea.com/users/422893/articles/528503-evaluation-of-four-pre-operative-models-for-prediction-of-biochemical-recurrence-after-radical-prostatectomy-in-localized-prostate-cancer

Hosted file

`Figure 2.docx` available at https://authorea.com/users/422893/articles/528503-evaluation-of-four-pre-operative-models-for-prediction-of-biochemical-recurrence-after-radical-prostatectomy-in-localized-prostate-cancer