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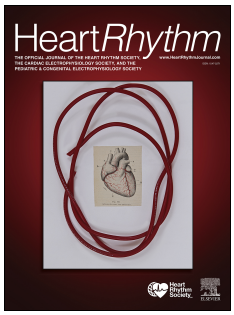

Integration of PRAETORIAN Score, Defibrillation Testing and Follow-Up Outcomes for the Assessment of Conversion Failure in Patients with Subcutaneous Implantable Cardioverter Defibrillator: results from the i-SUSI registry

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Integration of PRAETORIAN Score, Defibrillation Testing and Follow-Up Outcomes for the Assessment of Conversion Failure in Patients with Subcutaneous Implantable Cardioverter Defibrillator: results from the i-SUSI registry

Praetorian Score & DFT

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ABSTRACT

Background. Although reports of good clinical outcomes after avoiding defibrillation testing (DFT) during subcutaneous implantable cardioverter defibrillator (S-ICD) implantation have increased over recent years, current guidelines still recommend performing DFT at the time of implant.

Objective. We aimed to identify predictors of conversion failure in a real-world S-ICD population and assess whether PRAETORIAN score performance is improved by additional clinical variables.

Methods. We analyzed 1063 patients from the international iSUSI registry with available imaging and complete follow-up. The primary endpoint was a composite of DFT failure and ineffective appropriate shocks during follow-up. PRAETORIAN score and individual components were assessed, and ROC curve analysis with DeLong's test was used to evaluate model performance.

Results. Patients were classified into low (76.6%), intermediate (16.3%), and high-risk (7.2%) PRAETORIAN score categories. Among 748 patients who underwent DFT, 64 (8.6%) experienced DFT failure; 17 ineffective shocks occurred during follow-up. Primary outcome occurred in 4.5% of low, 6.7% of intermediate-, and 16.8% of high-risk patients. PRAETORIAN score Step-1, anterior generator position at PRAETORIAN score Step-2 (OR 2.3 [1.2–4.2], p=0.006), high BMI and post-shock impedance, independently predicted conversion failure. Overall PRAETORIAN score (AUC 0.71) outperformed individual steps (Step 1–3 AUCs: 0.68–0.70; p>0.05 for all comparisons). A multivariable model combining PRAETORIAN score, BMI, and impedance significantly improved predictive accuracy (AUC 0.78vs.0.71; p=0.0078).

Conclusion. PRAETORIAN score, BMI, and impedance are independent predictors of defibrillation failure. Their combined use may improve risk stratification and may help guide clinical decision-making, especially when DFT is omitted.

Keywords: S-ICD; defibrillation testing; ineffective shocks; defibrillator; PRAETORIAN score.

INTRODUCTION

Subcutaneous implantable cardioverter defibrillators (S-ICDs) have established themselves as a safe and effective alternative to transvenous systems for preventing sudden cardiac death (SCD) in patients without pacing indications[1,2]. Unlike transvenous ICDs, S-ICDs rely on anatomical landmarks rather than fluoroscopic guidance, resulting in greater variability in implant positioning, which may affect shock efficacy. Despite mounting evidence supporting the safety of omitting defibrillation testing (DFT) during S-ICD implantation[3–5], current guidelines still recommend DFT at the time of implant[6].

Performing DFT stems from concerns about the S-ICD's reliance on surface sensing, potential for suboptimal positioning, and lack of ATP or bradycardia pacing[7]. However, DFT itself carries procedural risks[8] and offers probabilistic outcomes[9] that may not always reflect real-world performance. Furthermore, DFT requires additional dedicated personnel (i.e. anesthesia support), thus posing additional logistical and financial strain on most healthcare systems.

The PRAETORIAN score is an imaging-based tool developed to quantify the risk of conversion failure based on device positioning and patient anatomy, assessed via post-implantation chest X-ray or intra-procedural fluoroscopy[10,11]. Although the PRAETORIAN score has been validated in single-center and retrospective cohorts[12], including a recent large real-world analysis confirming its predictive value for unsuccessful defibrillation testing, its performance across broader multicenter populations and in relation to real-world shock efficacy remains incompletely characterized.

METHODS

The iSUSI (International SUbcutaenous Implantable cardioverter defibrillator registry) collaboration – former ELISIR project[13] – is a multi-center, international, physician-initiated independent registry (NCT05390047). The registry includes 22 public and private institutions across Europe and North America. The detailed composition of this registry has been reported elsewhere[14]. The registry has been approved by the local institutional review boards. This manuscript has been drafted in compliance with the Declaration of Helsinki. The data that support the findings of this study are available from the corresponding author upon reasonable request.

Study Design and Population

Data collection methods for the patients enrolled in this registry have been previously presented[15,16]. All consecutive patients undergoing implantation of an S-ICD device (*Boston Scientific, Marlborough, MA, USA*) enrolled in the iSUSI registry from January 2015 to January 2023 were screened for potential inclusion in the study. This sub-analysis included all consecutive patients who underwent S-ICD implantation and met the following criteria:

- Availability of intra-procedural fluoroscopy or post-implantation two-view chest radiography suitable for PRAETORIAN score calculation;
- Complete documentation of defibrillation testing (DFT) outcomes, if performed; analyses were restricted to complete cases, with no replacement of missing data;
- Proper ascertainment of peri-procedural and follow-up outcomes.

PRAETORIAN Score Assessment and Risk Stratification

The PRAETORIAN score was calculated using previously published criteria from either intra-procedural fluoroscopy or post-procedural chest radiography[10,11]. Risk classes for conversion failure were defined as:

- Low risk: <90 points

- Intermediate risk: 90–149 points
- High risk: ≥150 points

BMI correction was applied as per original score methodology[10]. In addition, individual PRAETORIAN score components (Step 1–3) were separately analyzed for their association with the primary outcome. In patients who underwent intra-procedural or in-hospital device revision, the PRAETORIAN score used for the primary outcome analysis was the one obtained from chest radiography performed after the final repositioning and prior to discharge, reflecting the definitive device configuration throughout follow-up.

Definitions and Outcomes

- Defibrillation Testing (DFT) Success. DFT was considered successful when an induced VA (induced by a transthoracic 50-Hz burst pacing) was terminated within 5 seconds after a first 65J shock. The first test used shock in standard polarity (coil-to-can); if unsuccessful, a second test was performed with reversed polarity (can-to-coil). If a VA could not be induced after three attempts, a 10J shock was delivered to evaluate high voltage impedance. This definition is in accordance to the randomized PRAETORIAN-DFT Trial[17].
- Inappropriate Shock: A shock delivered in the absence of a shockable ventricular arrhythmia, due to supraventricular tachycardia, oversensing, or artifact.
- Appropriate Shock: A shock delivered for a correctly identified episode of sustained ventricular tachycardia (VT) or ventricular fibrillation (VF).
- Ineffective Shock: An appropriate shock that failed to terminate VT or VF.
- High Impedance: Post-shock impedance ≥80 ohms was predefined as a marker of possible suboptimal current delivery.

The primary endpoint was a composite of DFT failure and ineffective appropriate shocks during follow-up.

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation (SD) or median [interquartile range, IQR], depending on data distribution. Categorical variables were presented as absolute counts and percentages. Comparisons between groups were performed using Pearson's chi-squared test or Fisher's exact test for categorical variables and Student's t-test or Mann–Whitney U test for continuous variables. Variables included in the multivariable logistic regression model were selected based on clinical relevance and univariate significance and are detailed in the corresponding table. Specifically, the multivariable model included PRAETORIAN score class, BMI, post-shock impedance, age, LVEF, amiodarone therapy, implant technique (two- vs three-incision), and device placement (intermuscular vs subcutaneous). All regression analyses were performed at the patient level. The composite endpoint was defined as the occurrence of either DFT failure at implant or at least one ineffective appropriate shock during follow-up, and each patient contributed only once to the analysis irrespective of the number of arrhythmic events observed. Receiver operating characteristic (ROC) curve analysis was performed to assess the discriminative ability of the PRAETORIAN score, BMI, and impedance for predicting the primary outcome, and to identify optimal thresholds using Youden's Index. To compare the performance of predictive models (e.g., PRAETORIAN score alone vs. combined models including BMI and impedance), we used DeLong's test for paired ROC curves. This non-parametric test allowed for formal comparison of AUC values from correlated models, with statistical significance defined as a two-tailed p-value <0.05. All statistical analyses were conducted using Stata version 14.0 (StataCorp LLC, College Station, TX, USA). A two-tailed p-value <0.05 was considered statistically significant.

RESULTS

Study Cohort and Peri-procedural data

Of the 1698 patients enrolled in the iSUSI registry, granular data regarding DFT outcomes and PRAETORIAN score calculation were available for 1063 subjects, who represented the study cohort. The mean age was 52.7±15.6 years and 77.0% of the patients were male. BMI and LVEF at the time of S-ICD placement were 26.2±4.9 kg/m2 and 41.0±16.0%, respectively. The most common underlying cardiac substrate was an ischemic cardiomyopathy (37.4%), followed by dilated cardiomyopathy (22.4%). **Table1** summarizes baseline characteristics of the study cohort. **Supplementary Tables 1-2** summarize baseline characteristics by DFT and primary outcome.

As detailed in **Table2**, most S-ICD implants were performed using the two-incision technique (91.4%), with the remaining 8.6% utilizing a three-incision approach. Intermuscular device placement was the predominant method (86.6%), while only 13.4% of devices were placed subcutaneously. The median procedural time was 60 minutes [IQR 45–72]. Standard shock polarity was programmed in 95.0% of cases, with the primary sensing vector selected in 65.2% of patients, followed by the secondary (27.3%) and alternative (7.5%) vectors. The median conditional and shock zones were 200 bpm [IQR 200–220] and 240 bpm [IQR 240–250], respectively.

PRAETORIAN Score Distribution, Defibrillation Testing and Follow-up Outcomes

PRAETORIAN scores classified patients into low-risk (814, 76.6%), intermediate-risk (173, 16.3%), and high-risk (76, 7.2%) groups (**Table3, Supplementary Figure1**). DFT was performed in 748 (70.4%) patients, with a successful arrhythmia termination in 684/748 (91.4%) cases. Actions taken in case of DFT failure are summarized in **Supplementary Table 3**. During a median follow-up of 24.8 [13.1–39.3] months, 115 patients (10.8%) experienced 374 appropriate shocks (median 1 [1–3]/patient), including 17 ineffective shocks (4 low-risk, 2 intermediate-risk, 11 high-risk). Details of these events are provided in **Supplementary Table4**. The primary outcome occurred in 4.5% of low-risk, 6.7% of intermediate-risk, and 16.8% of high-risk patients ($p<0.001$), demonstrating a

progressively increasing risk of failure across PRAETORIAN score categories. Inappropriate shocks occurred in 95 patients (8.9%, median 1 [1–3] IAS/patient) over the follow-up period. These were most commonly due to T-wave oversensing and supraventricular arrhythmias, consistent with previously reported mechanisms in S-ICD recipients[18].

At logistic regression analysis (**Table4**), PRAETORIAN score was an independent predictor of the composite primary outcome both for intermediate risk patients (OR 2.2 [1.2–4.4], p=0.017) and for high-risk patients (OR 3.5 [1.7–8.0], p=0.001). Step 1 of the PRAETORIAN score (coil count >3) was the strongest individual predictor (OR 11.8 [3.0–45.9], p<0.001). Generator position anterior to midline (Step 2) (OR 2.3 [1.2–4.2], p=0.006), as well as high BMI (OR 2.4 for BMI ≥25, p=0.003) and high post-shock impedance (OR 9.7 [4.6–20.7], p<0.001) were also associated with the primary combined outcome. Other variables were not associated with conversion failure.

Subsequently, the discriminative performance of the PRAETORIAN score and its individual components (Steps 1–3) for predicting defibrillation failure were evaluated. The AUCs for Step 1, Step 2, and Step 3 were 0.68, 0.70, and 0.70, respectively. Pairwise comparisons between the individual steps using DeLong's test revealed no statistically significant differences: Step 1 vs Step 2 (p=0.56), Step 1 vs Step 3 (p=0.48), and Step 2 vs Step 3 (p=0.89), indicating comparable predictive performance across components. The total PRAETORIAN score achieved an AUC of 0.71 (**Figure1**). To explore whether predictive accuracy could be enhanced by integrating additional clinical parameters, we built a multivariable logistic regression model combining the PRAETORIAN score with BMI and post-shock impedance. This combined model yielded a significantly higher AUC of 0.78 (**Figure2**). The difference in AUC between the PRAETORIAN score alone and the combined model was statistically significant (p=0.0078, DeLong's test), confirming that the addition of BMI and impedance meaningfully improves the model's ability to discriminate defibrillation outcomes. In this multivariable model, the PRAETORIAN score demonstrated the highest individual AUC, outperforming both BMI and impedance. The optimal cutoffs were identified at a BMI ≥ 27.3 kg/m2

and an impedance of 81Ω, suggesting that patients with elevated BMI and high shock impedance are at increased risk of experiencing the primary outcome.

DISCUSSION

This study, leveraging real-world data from the international iSUSI registry, provides new insights into predictors of defibrillation failure in patients undergoing S-ICD implantation. Our findings can be summarized in three major observations:

- First, a high PRAETORIAN score, elevated BMI, and increased post-shock impedance are independent predictors of conversion failure, defined as either DFT failure or ineffective appropriate shocks during follow-up.
- Second, the total PRAETORIAN score was a more reliable discriminator of conversion failure than its individual components. Although each step showed moderate predictive ability, pairwise comparisons revealed no significant differences. This supports the use of the integrated score, which provides greater clinical utility than isolated parameters.
- Third, and most importantly, we demonstrate that a multivariable model incorporating the PRAETORIAN score, BMI, and impedance significantly improves the prediction of conversion failure, yielding an AUC of 0.78 compared to 0.71 for PRAETORIAN score alone ($p=0.0078$, DeLong test). Although the absolute increase in AUC from 0.71 to 0.78 is moderate, the improvement was statistically significant and suggests that integrating BMI and impedance provides incremental discriminative value beyond the PRAETORIAN score alone.

Real-World Shock Failure, Not Just DFT

A unique strength of our study is the inclusion of ineffective appropriate shocks during follow-up in the composite outcome. Prior research on the PRAETORIAN score-including work by Quast et al.[10] and a sub-analysis of the PRAETORIAN-DFT trial[19]-focused primarily on DFT failure. However, DFT outcomes may vary despite identical shock strength, reflecting transient myocardial and physiological factors[5,9]. Importantly, DFT does not replicate the hemodynamic and metabolic conditions of spontaneous arrhythmias. Therefore, pivotal trials and surveys-including SIMPLE and NORDIC ICD[20–22]-have shown that omitting DFT in transvenous ICDs is non-inferior to routine

testing with respect to both mortality and shock efficacy. There are multiple technical reasons behind the performance of DFT in S-ICDs[7]. S-ICDs rely on single-vector morphology-based sensing and anatomical landmark–guided implantation, both of which contribute to variability in final device position and defibrillation efficacy. At the same time, the growing interest in avoiding DFT performance for S-ICD recipients is not unsurprising. DFT is, in fact, not exempt from complications. Albeit having a low incidence rate, these complications may be severe and are reported occurring more frequently in patients with a reduced left ventricular function. Taken together, these limitations reduce the clinical interpretability of DFT results[9]. Instead, by incorporating real-world ineffective shocks, our analysis enhances external validity and supports a shift from reliance on DFT toward more reproducible, anatomy- and physiology-based risk models.

Simpler or More Accurate?

In their recent multicenter analysis, Ziacchi et al.[23] proposed a simplification of the PRAETORIAN score, suggesting that modern intermuscular implant techniques reduce the relevance of certain score components. In their cohort of 1,253 patients, 95.7% had PRAETORIAN scores <90, reflecting improved implant technique and minimal sub-generator fat. Notably, BMI was the only independent predictor of an elevated score, and an impedance >88 Ω had a 98% negative predictive value for a score ≥90. Their proposal was elegant: streamline the score by eliminating Steps 2 and 3, and rely on impedance as a surrogate for sub-coil fat. However, our findings challenge this notion. Although individual score components showed comparable discrimination, the total PRAETORIAN score consistently performed better. Thus, combining the full PRAETORIAN score with impedance and BMI significantly improves predictive accuracy (AUC=0.78, p=0.0078, DeLong test). Additionally, our composite outcome includes ineffective shocks during follow-up-not just intra-procedural DFT failure-making our model more clinically relevant and representative of long-term risk. This distinction is further supported by findings from de Veld et al.[24], who showed that impedance values can vary significantly at the time of generator replacement, despite consistently high DFT conversion

rates. This variability indicates that impedance may not be a stable or standalone predictor of long-term defibrillation efficacy. Device positioning-specifically generator depth and posterior contact (Steps 2 and 3 of the PRAETORIAN score)-plays a more durable and reproducible role. Similarly, van der Stuijt et al.[25] demonstrated a significant increase in impedance at generator replacement compared to initial implant (from 77±26 Ω to 86±28 Ω), yet the first shock conversion rate remained high at 91.4%, likely due to consistently favorable generator positioning based on the PRAETORIAN score. These findings collectively reinforce that positioning remains the critical determinant of defibrillation success, even when impedance fluctuates over time. Importantly, the PRAETORIAN-DFT trial[17] found that systematic use of the full score did not increase repositioning rates in the no-DFT arm — and indeed, repositioning was predominantly driven by post-implant imaging review rather than DFT failure results. This underscores the score's role as an active driver of implant quality, not merely a passive risk stratification tool.

Rather than simplifying the PRAETORIAN score, we advocate for refining it through accuracy and comprehensiveness. The score is easy to calculate using standard post-implant X-rays or fluoroscopy and requires no additional imaging or procedural burden. Step 2 (generator position) and Step 3 (distance from the thoracic wall) can be assessed in seconds and contribute valuable risk stratification. Simplification is tempting, particularly in high-volume workflows, but as our data demonstrate, precision yields deeper clinical insight. In this light, our study does not reject the efforts of Ziacchi et al.[23] but builds upon them. We agree that impedance is a useful metric, but our work emphasizes that it should not be viewed as a standalone proxy for device positioning. Importantly, shock impedance measured during DFT should be interpreted as a marker associated with conversion efficacy rather than a true pre-procedural predictor of DFT outcome, as it becomes available only after shock delivery. Nevertheless, it may still provide useful mechanistic insight into the electrical coupling between the device system and thoracic tissues and may therefore help explain differences in defibrillation efficacy. A more robust, future-facing model integrates anatomical, physiological, and anthropometric data: PRAETORIAN+impedance +BMI. Our findings are consistent with the

recent validation study by Doldi et al.[12], who evaluated the PRAETORIAN score in a large single-center cohort of 398 S-ICD recipients undergoing intraoperative defibrillation testing. In that study, the PRAETORIAN score independently predicted unsuccessful DFT, whereas BMI did not retain independent predictive value in multivariable analysis. In contrast, in multivariable analyses including clinically relevant covariates, BMI and high-voltage impedance remained independently associated with the composite endpoint and improved the discriminative performance of the PRAETORIAN score. These differences may reflect the broader case-mix and real-world procedural heterogeneity of our international cohort as well as the inclusion of ineffective clinical shocks during follow-up rather than DFT outcomes alone.

Role of BMI

Francia et al.[26] have previously proposed that the intermuscular implantation technique may help prevent anterior malpositioning of the S-ICD and reduce fat interposition between the generator and the thoracic wall, thereby improving shock vector orientation and defibrillation efficacy. Despite these advantages, suboptimal positioning remains a non-negligible concern even with contemporary intermuscular techniques. Specifically, we observed that between 16.5% and 20.2% of these patients still exhibited suboptimal generator position (Step 2), and 6.8% to 14.1% demonstrated excessive interposition of tissue beneath the generator and the thoracic wall (Step 3). While Ziacchi et al. suggested that impedance alone may act as a surrogate marker[27], our data indicate that generator positioning remains relevant. In patients with high BMI, for example, anatomical landmarks may be less reliable, and soft tissue distribution more variable, making precise generator positioning more challenging despite optimal surgical technique. Moreover, patient-related factors, such as body habitus and subcutaneous fat distribution, can independently affect impedance and defibrillation thresholds. Frankel et al.[28], analyzing 321 S-ICD patients from the IDE study, evaluated whether obesity increased the risk of failed shocks. In this cohort, obese patients-particularly those with a BMI >30 kg/m²-were found to be at increased risk of failed first S-ICD shocks during DFT. The authors

concluded that whether this risk can be mitigated through optimal implantation techniques remains unclear. For this reason, we incorporated both impedance and BMI into our risk model, recognizing their complementary roles. This combined approach was validated by ROC analysis, where the addition of both variables to the PRAETORIAN score yielded superior predictive performance compared to using impedance or BMI alone. Notably, patients with higher BMI remained at elevated risk of conversion failure, only when accompanied by a suboptimal PRAETORIAN score and elevated impedance. These findings highlight that the quality of implantation is the most critical factor influencing defibrillation success. This observation is consistent with mechanistic insights: excess sub-coil fat increases thoracic impedance, which impairs current delivery and reduces the shock field across the myocardium. However, it should also be emphasized that our cohort exhibited a relatively narrow distribution of BMI and impedance values, and therefore the magnitude of these associations may differ in populations with a broader range of anthropometric or electrical characteristics.

Clinical Implications and Future Directions

Our results advocate for a more refined and personalized approach to risk stratification in S-ICD recipients. By incorporating readily available data-PRAETORIAN score, impedance, and BMI-clinicians can make informed decisions about whether to perform DFT and whether repositioning is needed after implant if DFT is not performed or fails. While current guidelines still recommend DFT[6], mounting evidence (including ours) supports the use of PRAETORIAN scoring, impedance, and BMI as more reliable and clinically relevant indicators of long-term defibrillation success. This position is now definitively supported by the recently published PRAETORIAN-DFT randomized trial[17], the first RCT to demonstrate non-inferiority of DFT omission guided by the PRAETORIAN score, with failed first shock rates of 1.7% vs. 2.3% in the no-DFT vs. DFT groups respectively, and no difference in arrhythmic mortality. Our findings complement this landmark result: as DFT is increasingly omitted, the combined model of PRAETORIAN score + BMI + impedance provides the incremental

risk stratification layer needed to identify patients who remain at elevated risk despite a low-risk score.

Limitations

As with any registry-based study, our analysis is observational and subject to potential confounding. First, although we employed multivariable modeling to adjust for clinically relevant covariates, residual confounders cannot be fully excluded. The primary endpoint of shock failure—particularly ineffective appropriate shocks during follow-up—relies on accurate device interrogation and consistent data reporting across centers. Second, it is also important to acknowledge that in patients who died without device interrogation or in whom follow-up data were incomplete or lost, the true incidence of ineffective shocks may have been underestimated. This limitation could introduce a degree of bias in our assessment of long-term outcomes, particularly in the most clinically vulnerable subgroup. However, given the large sample size and consistent methodology across centers, we believe our findings remain robust and broadly generalizable. Third, shock impedance was measured during defibrillation testing and therefore cannot be considered a true pre-procedural predictor of DFT success; accordingly, its role in this analysis should be interpreted as associative rather than strictly predictive. Fourth, data on patient race and ethnicity were not systematically collected across participating centers in the iSUSI registry and were therefore not available for analysis. As a result, we could not evaluate potential differences in defibrillation outcomes across racial groups, which may limit the generalizability of our findings. Fifth, this analysis was restricted to patients with available DFT outcome data and imaging suitable for PRAETORIAN score calculation. This complete-case approach may introduce some degree of selection bias; however, inclusion of patients with incomplete data for these key variables could have introduced greater misclassification bias and reduced the reliability of the analyses. Sixth, the PRAETORIAN score was assessed locally by the implanting physicians without central core laboratory adjudication. Although the score relies on relatively simple radiographic measurements, some degree of inter-observer variability cannot be

excluded. Lastly, only high-voltage shock impedance was available in the registry. As this parameter requires shock delivery, it may not be available in clinical scenarios where DFT is omitted. Future studies should investigate whether low-voltage system impedance could serve as a surrogate marker.

Conclusion

High PRAETORIAN score, BMI, and impedance are independent predictors of defibrillation failure in S-ICD recipients. A combined model integrating these variables improves risk stratification and may help guide clinical decision-making in the era of selective DFT omission.

FIGURE LEGENDS

Figure1

ROC curve: PRAETORIAN score (overall and components).

Figure2

ROC curve combined model: Praetorian Score (overall) + BMI + impedance.

Tables abbreviations: BMI=body mass index; DFT=defibrillation testing; IQR=interquartile range; LVEF=left ventricular ejection fraction.

Table1: Baseline characteristics of the Study Cohort (n = 1063)	
Age (years), mean±s.d.	52.7±15.6
Male, n (%)	818(77.0)
BMI, mean±s.d.	26.2±4.9
Diabetes, n (%)	212(19.9)
Hypertension, n (%)	474(44.6)
LVEF (%), mean±s.d.	41.0±16.0
Primary Prevention Implant, n (%)	663(62.4)
Underlying Cardiac Disease, n (%)	
Ischemic cardiomyopathy	*397(37.4)*
Dilated cardiomyopathy	*238(22.4)*
Hypertrophic cardiomyopathy	*98(9.2)*
Arrhythmogenic cardiomyopathy	*41(3.9)*
Brugada syndrome	*81(7.6)*
Idiopathic ventricular fibrillation	*81(7.6)*
Long-QT syndrome	*22(2.1)*
Myocarditis	*32(3.1)*
Alcoholic cardiomyopathy	*8(0.1)*
Valvular cardiomyopathy	*22(0.2)*
Other	43(4.0)
History of atrial fibrillation, n (%)	209(19.7)
Beta-blockers, n (%)	849(80.6)
Amiodarone, n (%)	139(13.1)

Table2: Peri-Procedural Data (n = 1063)	
Implant Technique, n (%)	
Two Incision Technique	912(91.4)
Three Incision Technique	92(8.6)
Device Placement, n (%)	
Subcutaneous	142(13.4)
Inter-muscular	921(86.6)
Procedural time (min), median [IQR]	60[45–72]
Programming	
Conditional shock zone (bpm), median [IQR]	200[200–220]
Shock zone (bpm), median [IQR]	240[240–250]
Standard Polarity, n (%)	1010(95.0)
Primary vector, n (%)	693(65.2)
Secondary vector, n (%)	290(27.3)
Alternative vector, n (%)	80(7.5)
DFT (defibrillation testing) performance, n (%)	748(70.4)
DFT success	684(91.4)
DFT failure	64(8.6)
Post-shock impedance (ohm), mean±s.d.	68.3±17.5
PRAETORIAN score, median [IQR]	30[30–60]
Low Risk Class, n (%)	814(76.6)
Intermediate Risk Class, n (%)	173(16.3)
High Risk Class, n (%)	76(7.2)

Table 3: PRAETORIAN Score Specifics	
PRAETORIAN score assessment	
Fluoroscopy + chest X-ray	40 (3.8)
Intraprocedural fluoroscopy only	69 (6.5)
Chest X-ray only	954 (89.7)
PRAETORIAN Step1, n (%)	
≤, 1 coil, n (%)	755(71.0)
Between >1 & ≤ 2 coils, n (%)	247(23.2)
Between >2 & ≤ 3 coils, n (%)	51(4.8)
>3 coils, n (%)	10(0.9)
PRAETORIAN Step2, n (%)	
Generator on or posterior to midline, n (%)	848(79.8)
Entire generator is anterior to the midline, n (%)	155(14.6)
Entire generator is >1/2 length anterior, n (%)	60(5.6)
PRAETORIAN Step3, n (%)	
< 1 generator width, n (%)	885(83.3)
≥ 1 generator width, n (%)	178(16.7)
BMI correction, n (%)	
-40 Credit, n (%)	390(36.6)
None, n (%)	873(63.4)

Table 4: Combined Outcome Predictors		
	Odds Ratio [IQR]	p
PRAETORIAN Score Class		
Intermediate risk	2.2 [1.2–4.4]	0.017
High-risk	3.5 [1.7–8.0]	0.001
PRAETORIAN Step1		
Between >1 & ≤ 2 coils, n (%)	2.0 [1.1–3.7]	0.022
Between >2 & ≤ 3 coils, n (%)	3.4 [1.4–8.4]	0.006
>3 coils, n (%)	11.8 [3.0–45.9]	<0.001
PRAETORIAN Step2		
Entire generator is anterior of the midline	2.3 [1.2–4.2]	0.006
Entire generator is >1/2 length anterior	0.5 [0.1–3.7]	0.494
PRAETORIAN Step3		
≥ 1 generator width, n (%)	1.7 [0.9–3.3]	0.122
BMI (continuous)	1.1 [1.1–1.2]	<0.001
BMI (≥25)	2.4 [1.3–4.3]	0.003
BMI (≥30)	2.7 [1.6–4.8]	<0.001
BMI (≥35)	4.7 [2.2–9.9]	<0.001
High impedance (≥ 80 ohm)	9.7 [4.6–20.7]	<0.001
Age (continuous)	1.0 [0.9–1.1]	0.802
LVEF (continuous)	1.0 [0.9–1.1]	0.901
LVEF (≥50)	1.2 [0.7–2.0]	0.551
LVEF (≥35)	1.1 [0.6–1.8]	0.817
Amiodarone	0.6 [0.2–1.4]	0.214
Two Incision Technique	5.2 [0.7–38.1]	0.106
Inter-muscular placement	0.9 [0.4–1.7]	0.678

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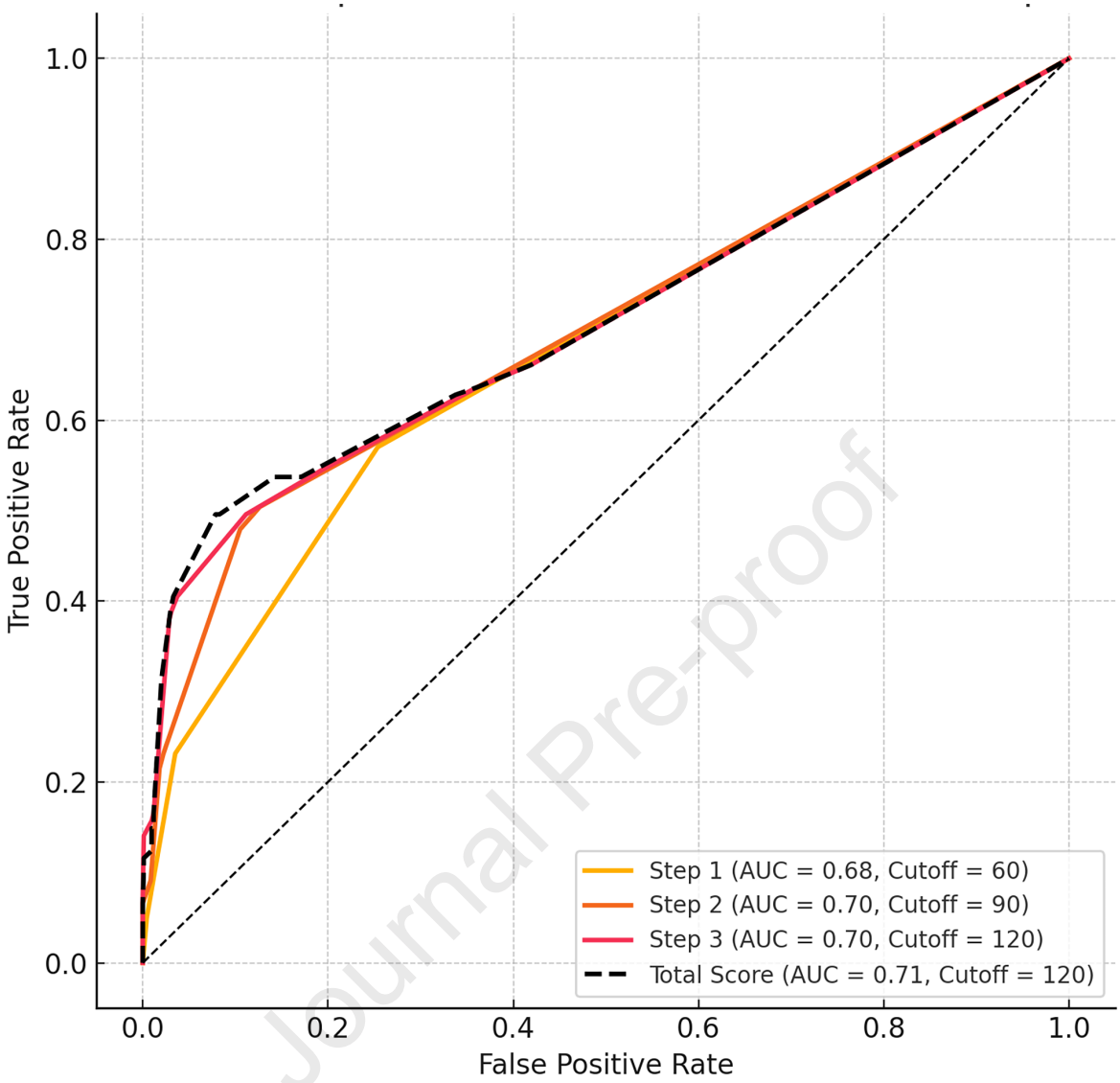

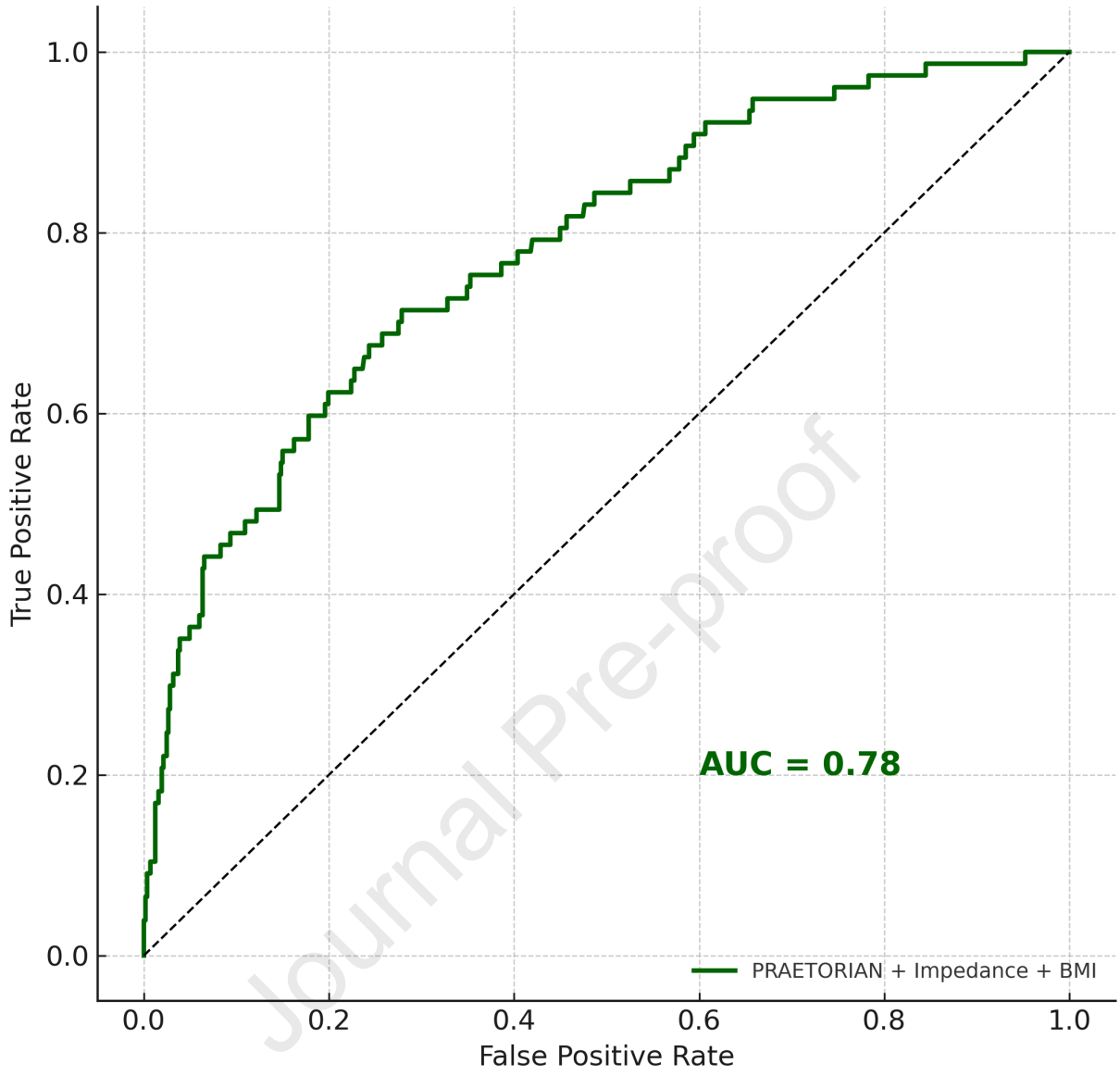

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Supplementary Table1: Baseline characteristics of the study cohort stratified by DFT (defibrillation testing).

Abbreviations: BMI: body mass index, LVEF: left ventricular ejection fraction.

	DFT (n=748)	No-DFT (n=315)	p
Age (years), mean±s.d.	51.0±15.6	56.9±14.6	<0.001
Male, n (%)	568 (75.9)	250 (79.4)	0.225
BMI, mean±s.d.	26.1±4.9	26.4±4.7	0.405
Diabetes, n (%)	124 (16.6)	88 (27.9)	<0.001
Hypertension, n (%)	324 (43.3)	150 (47.7)	0.197
LVEF (%), mean±s.d.	43.8±16.7	34.3±11.7	<0.001
Primary Prevention Implant, n (%)	424 (56.7)	239 (75.9)	<0.001
Underlying Cardiac Disease, n (%)			
Ischemic cardiomyopathy	*246 (33.0)*	*150 (46.7)*	*<0.001*
Dilated cardiomyopathy	*140 (18.7)*	*98 (31.1)*	*<0.001*
Hypertrophic cardiomyopathy	*88 (11.8)*	*10 (3.2)*	*<0.001*
Arrhythmogenic cardiomyopathy	*36 (4.8)*	*5 (1.6)*	*0.013*
Brugada syndrome	*71 (9.5)*	*10 (3.2)*	*<0.001*
Idiopathic ventricular fibrillation	*73 (9.8)*	*8 (2.5)*	*<0.001*
Long-QT syndrome	*17 (2.3)*	*5 (1.6)*	*0.473*
Myocarditis	*23 (3.1)*	*9 (2.9)*	*0.850*
Other	*53 (7.1)*	*20 (6.3)*	*0.665*
History of atrial fibrillation, n (%)	114 (15.2)	95 (30.2)	<0.001
Beta-blockers, n (%)	572 (77.4)	277 (87.9)	<0.001
Amiodarone, n (%)	96 (12.9)	43 (13.7)	0.724

Supplementary Table2: Baseline characteristics of the study cohort stratified by the primary outcome.

Abbreviations: BMI: body mass index, LVEF: left ventricular ejection fraction.

	Primary combined endpoint (n=81)	No primary combined endpoint (n=982)	p
Age (years), mean±s.d.	51.2±16.2	52.9±15.5	0.350
Male, n (%)	62 (76.5)	756 (77.0)	0.928
BMI, mean±s.d.	28.4±5.5	26.0±4.8	<0.001
Diabetes, n (%)	14 (17.3)	198 (20.2)	0.533
Hypertension, n (%)	41 (50.6)	433 (44.1)	0.256
LVEF (%), mean±s.d.	42.5±16.2	40.8±15.9	0.388
Primary Prevention Implant, n (%)	49 (60.5)	614 (62.5)	0.717
Underlying Cardiac Disease, n (%)			
Ischemic cardiomyopathy	*30 (37.0)*	*367 (37.4)*	*0.952*
Dilated cardiomyopathy	*17 (21.0)*	*221 (22.5)*	*0.753*
Hypertrophic cardiomyopathy	*3 (3.7)*	*95 (9.7)*	*0.074*
Arrhythmogenic cardiomyopathy	*3 (3.7)*	*38 (3.9)*	*0.941*
Brugada syndrome	*10 (12.5)*	*71 (7.2)*	*0.087*
Idiopathic ventricular fibrillation	*7 (8.6)*	*74 (7.5)*	*0.718*
Long-QT syndrome	*1 (1.2)*	*21 (2.1)*	*0.583*
Myocarditis	*2 (2.5)*	*30 (3.1)*	*0.767*
Other	*7 (8.6)*	*66 (6.7)*	*0.511*
History of atrial fibrillation, n (%)	17 (21.0)	192 (19.6)	0.755
Beta-blockers, n (%)	63 (77.8)	786 (80.8)	0.512
Amiodarone, n (%)	10 (12.3)	129 (13.1)	0.837

Supplementary Table3: Management of patients with defibrillation testing failure and PRAETORIAN score assignment

Abbreviations: AV: atrioventricular, DFT: defibrillation testing, VF: ventricular fibrillation.

Category	n	Management of DFT Failure	PRAETORIAN Score Used in Analysis
Intra-procedural or in-hospital device revision			
Lead and/or generator repositioned (pocket reopening when required)	11	Device revision performed intra-procedurally or during the same hospitalization; all patients achieved DFT success after repositioning	Post-repositioning score from chest X-ray obtained after revision and prior to discharge; median 30 [IQR 30–60] (range 30–90)
No device revision			
High-voltage shock termination without device modification	48	VF terminated by a subsequent shock (either >65J in standard polarity or ≥65J in reversed polarity) during the same procedure or before discharge; no repositioning performed	Post-implantation chest X-ray score (no device modification)
Asystole or high-degree AV block	2	VF conversion attempt complicated by asystole or high-degree AV block requiring temporary or permanent pacing; no repositioning performed	Post-implantation chest X-ray score (no device modification)
High-risk for repeat DFT — monitored and discharged	3	Deemed at excessive risk for repeat DFT attempt; monitored and discharged after failed DFT without further intervention	Post-implantation chest X-ray score (no device modification)
Total	**64**		

Supplementary Table4: Clinical outcomes of patients having an ineffective shock

Abbreviations: VF: ventricular fibrillation; VT: ventricular tachycardia.

	Arrhythmia Type	Number of Shocks	Outcome
Patient1	VT	1st failed, 2nd failed, 3rd successful	Survived
Patient2	VF	First 3 failed, 4th with reverse polarity successful	Survived
Patient3	VT	Partial data available: unclear number of shocks, but at least 4 and at least 1 with reverse polarity	Survived
Patient4	VF	First 4 ineffective, 1st reverse polarity ineffective, 2nd reverse polarity effective	Survived
Patient5	VT	1st failed, 2nd successful	Survived
Patient6	VT	1st failed, 2nd successful	Survived
Patient7	VT	1st failed, 2nd successful	Survived
Patient8	VT	1st failed, 2nd failed, 3rd successful	Survived
Patient9	VT	1st failed, 2nd successful	Survived
Patient10	VT	1st failed, 2nd successful	Survived
Patient11	VT	1st failed, 2nd successful	Survived
Patient12	VF	Partial data available: unclear number of shocks, at least 2	Survived
Patient13	VF	1st failed, 2nd failed, 3rd successful	Survived
Patient14	VT	1st failed, 2nd failed, 3rd successful	Survived
Patient15	VT	No data available	Survived
Patient16	VT	First 4 shocks failed	Death (VT slowed down below rate of detection)
Patient17	VT	1st failed, 2nd successful	Survived

Supplementary Figure1

PRAETORIAN Score and component distribution of the study cohort.