Critical Rounds
Vol 4 | Issue 45 | 2023

Critical Rounds Newsletter
VOL 5 | Issue 48 | 2024

Dear Doctor,

Greetings from Micro Labs Limited. We are happy to bring you **"Critical Rounds Newsletter"** which contain latest and interesting news in the field of Critical Care.

This issue contains:

1. Investigation of the prognostic value of the Procalcitonin and Albumin ratio for intensive care unit mortality in patients with sepsis

2. Evaluation of the safety of physical rehabilitation in critically sick patients

3. Identification of origin of fungal infections acquired in the intensive care unit using machine learning models

4. Case report on sudden cardiac arrest in a young person with several arrhythmic substrates

Should you require any article or, medical information, please feel free to contact us medicalservices@microlabs.in
free to contact us at medicalservices@microlabs.in
Looking forward to your valuable feedback

Best Regards,
Medical Team, Micro Labs Limited

Critical Rounds
Vol 4 | Issue 45 | 2023

Investigation of the prognostic value of the Procalcitonin and Albumin ratio for intensive care unit mortality in patients with sepsis

Introduction

Sepsis is a life-threatening condition with significant physiological and metabolic abnormalities. The Third International Consensus on sepsis (Sepsis-3) defines sepsis as "organ dysfunction caused by a dysregulated host response to infection," highlighting the importance of both innate and adaptive immune responses in the clinical condition. Sepsis affects 49 million people annually and is responsible for 11 million deaths, or up to 19.7% of all deaths globally.[1] Risk-stratifying patients with sepsis upon admission to the intensive care unit (ICU) is critical for determining treatment options and impacting outcomes. Studies indicate that assessing procalcitonin (PCT) levels can help diagnose and predict sepsis, as there was a link between PCT levels and infection severity. Serum albumin (ALB) is a negative acute phase protein that represents nutritional status. It has been proven to be an important predictor of outcomes in critically sick patients, indicating its potential as a predictive biomarker in sepsis. High procalcitonin (PCT) and low albumin (ALB) levels have been associated to mortality in sepsis.[2] The purpose of this study was to examine into the predictive usefulness of the PCT/ALB ratio for sepsis patients' mortality in the intensive care unit (ICU).

When PCT and serum ALB were used together, as shown by the PCT/ALB ratio, it was able to predict ICU mortality with an extent of accuracy that was marginally better than when PCT was used alone in the sepsis patients.

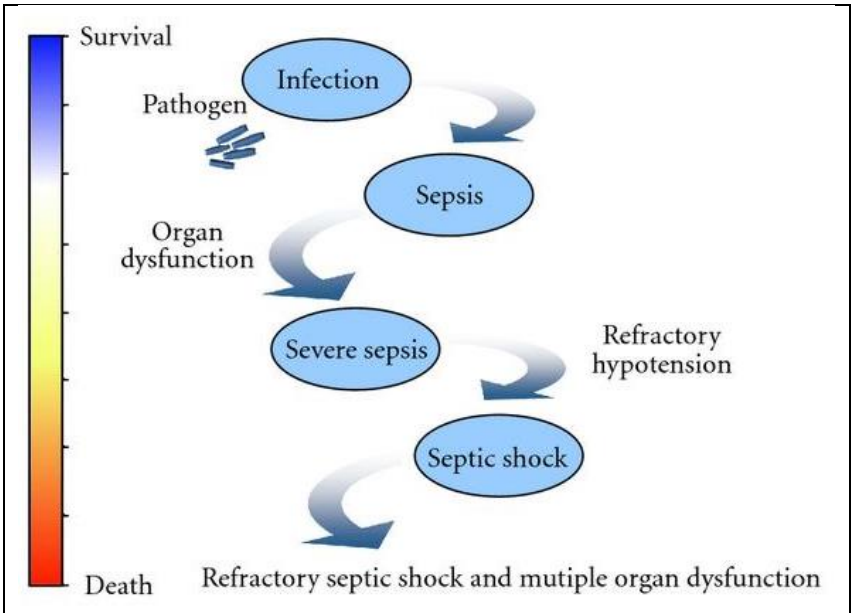

Fig. 1. A progression from infection to septic shock.

Methods

A three-year retrospective cohort analysis was carried out at a mixed intensive care unit. This study included consecutive adult ICU patients who met the Sepsis-3 Criteria and had simultaneous PCT and ALB measurements. Serum PCT was tested in the ICU with a point-of-care analyser. The main laboratory examined serum ALB levels during routine ICU investigations, with a reference range of 35 to 45 g/L. The PCT/ALB ratio was obtained by dividing serum PCT by serum ALB levels. The PCT/ALB ratio's predictive ability was evaluated using a receiver-operating characteristic (ROC) curve.

Critical Rounds
Vol 4 | Issue 45 | 2023

Results

A total of 185 sepsis patients were enrolled. The main outcome (all-cause ICU mortality) was 35.1%. In comparison to survivors, non-survivors had considerably greater baseline PCT and lower baseline ALB (25.4 [standard deviation, SD=31.2] vs. 9.8 [SD=20.0] ng/mL and 26.1 [SD=5.4] vs. 30.6 [SD=6.5] g/dL, respectively; P<0.001). Non-survivors had a substantially higher calculated PCT/ALB ratio than survivors (1.04 [SD=1.29] vs. 0.36 [SD=0.72]; P<0.001). The PCT/ALB ratio had a greater area under the ROC curve (AUC) for predicting ICU mortality (0.731, 95% CI: 0.658-0.804) compared to PCT alone (0.721, 95% CI: 0.647-0.796). In another ROC curve analysis, the PCT/ALB ratio outperformed both PCT and ALB used alone, with AUCs of 0.721 (95% CI: 0.651-0.785) and 0.700 (95% CI: 0.629-0.765), respectively (Fig 2). The ideal PCT/ALB ratio cut-off value was > 0.15, resulting in a sensitivity of 70.8% and specificity of 63.3%.

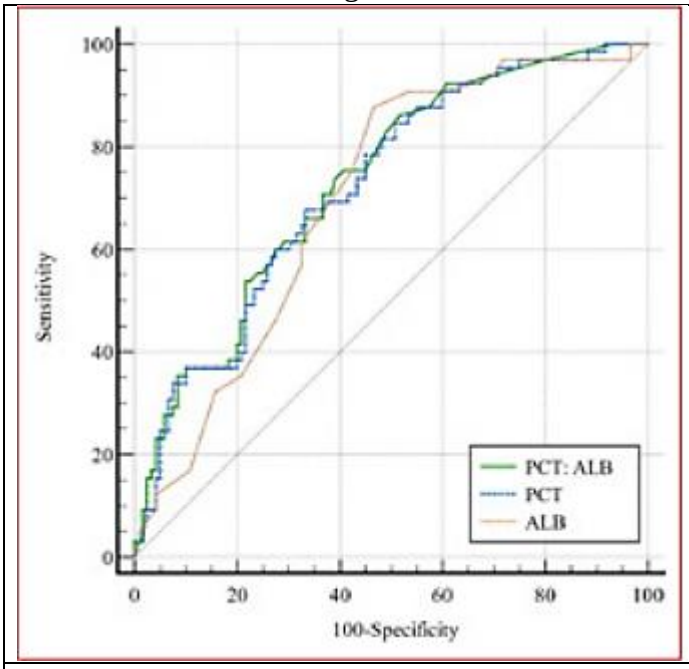

Figure 2. The procalcitonin to albumin ratio (PCT: ALB) as a predictor of ICU mortality in sepsis versus procalcitonin (PCT) and albumin (ALB) alone.

Discussion

This study found a significant association between serum PCT and ALB levels upon ICU admission and mortality rates in sepsis. In sepsis, the use of PCT in conjunction with serum ALB, or the PCT/ALB ratio, was found to be a slightly more effective way to predict ICU mortality than PCT alone. The ideal PCT/ALB ratio cut-off value was > 0.15, resulting in a sensitivity of 70.8% and specificity of 63.3%.[2] In a previous study by Iram Yunus et al. showed that procalcitonin was more selective for bacterial infections than other acute phase reactants. Although the initial procalcitonin level can be useful in determining the severity of a disease, it was not always a reliable prognostic predictor and has limited relevance as a standalone value. Sensitivity and specificity of procalcitonin for septic shock was 63 and 65% respectively.[3]

Conclusion

The PCT/ALB ratio modestly improved ICU mortality prediction over PCT alone. This might help predict sepsis, but more validation in a prospective multicenter trial is needed.

References

1. Jarczak D, Kluge S, Nierhaus A. Sepsis—pathophysiology and therapeutic concepts. Frontiers in medicine. 2021 May 14;8:628302.

2. Abd Manas SA, Ibrahim K, Ab Mukmin L, Shukeri WF. Procalcitonin to Albumin Ratio as a Predictor of Intensive Care Unit Mortality in Sepsis. Journal of Critical and Intensive Care. 2024 Apr;15(1): 23—29.
3. Yunus I, Fasih A, Wang Y. The use of procalcitonin in the determination of severity of sepsis, patient outcomes and infection characteristics. PLoS One. 2018 Nov 14;13(11):e0206527.

Evaluation of the safety of physical rehabilitation in critically sick patients

Introduction

Patients in intensive care units (ICUs) undergo physical rehabilitation or mobilisation to prevent physical complications and enhance patient outcomes.[1] ICU-acquired weakness, or ICU-AW, is a typical neuromuscular consequence of critical illness. Early mobilization of critically sick patients is a potential intervention to decrease the frequency and severity of ICU-AW. Early mobility has been shown in studies to minimize ICU and hospital stays, reduce mechanical ventilation time, increase long-term functional independence, and reduce mortality rates.[2] Physical therapy has minimal adverse event rates. However, recent study suggested that delivering a greater dosage at an earlier time point may be less safe and may not improve outcomes. The evaluation of ICU physical rehabilitation safety data was limited due to differences in how studies define their adverse event outcomes. When administering vasoactive medicines to critically sick patients, it was important to assess their cardiovascular capacity to ensure their safety during physical activity. So, this study aimed to develop a consensus among clinicians and patients on the definition of an adverse event during adult physical rehabilitation in an ICU and also, to achieve expert consensus among clinicians on the characteristics of adult ICU patients receiving vasoactive drugs who have a low or high risk of adverse events during physical rehabilitation, as well as those who are not suited to rehabilitation.

The adverse event tool can be used in physical rehabilitation studies to assess safety consistently.

Methods

A three-stage Delphi analysis was conducted to (a) define adverse events in a general ICU population and (b) determine which risks should be considered before physical rehabilitation for patients taking vasoactive medications. A multinational group of critical care specialists and clinical researchers participated. Former ICU patients and their families assisted in defining adverse events. Round one was an open round where people suggested what to include. In round two, participants assessed their agreement with these proposals on a five-point Likert scale, with a 70% consensus agreement criterion utilized. Round three involved

re-rating recommendations that did not reach consensus and reviewing anonymous participant ratings from round two.

Results

Twenty-four multi-professional ICU clinicians and clinician researchers from 10 countries from five continents were recruited. The average period of ICU experience was 18 years (standard deviation 8), and 61% had publications on ICU rehabilitation. Five previous ICU patients and one family were selected to define adverse events. The Delphi procedure had a 97% response rate. After reaching consensus on 54 adverse occurrences, an adverse event instrument was developed based on their findings. Only one event ('large amount of chest secretions') was accepted upon by the majority of patients/relatives, with 72.4% voting for exclusion and 66.7% voting to include (Table 1). Second, consensus was established on 50 risk variables for patients using vasoactive medications that should be assessed before physical rehabilitation. These recommendations influenced the development of a second tool.

Adverse event	Participant ratings (%)		
	Strongly disagree + disagree	Undecided	Agree + strongly agree
Events that reached consensus after round 2			
Large amounts of chest secretions			
All participants	72.4	10.3	17.2
Clinicians	87.0	8.7	4.3
Patients	16.7	16.7	66.7
Events that reached consensus after round 3			
Any respiratory deterioration			
All participants	82.8	0	17.2
Clinicians	95.7	0	4.3
Patients	33.3	0	66.7
Undecided events after round 3 (with round 3 ratings)			
Any cardiovascular deterioration			
All participants	65.5	3.4	31.0
Clinicians	78.3	0	21.7
Patients	16.7	16.7	66.7
Dizziness due to cardiovascular deterioration			
All participants	68.9	24.1	6.8
Clinicians	78.2	17.4	4.3
Patients	33.3	50.0	16.7
Any unplanned movement of any indwelling devices, lines, tubes or drains			
All participants	51.7	10.3	37.9
Clinicians	60.9	8.7	30.4
Patients	16.7	16.7	66.7
Increased pain			
All participants	69.0	6.9	24.1
Clinicians	78.3	0	21.7
Patients	33.3	33.3	33.3
Agitation			
All participants	62.1	0	37.9
Clinicians	69.6	0	30.4
Patients	33.3	0	66.7
Patient distress			
All participants	51.7	6.9	41.3
Clinicians	65.2	4.3	30.4
Patients	0	16.7	83.3
Bearing weight inappropriately on an injured leg			
All participants	41.4	10.3	48.2
Clinicians	52.2	8.7	39.1
Patients	0	16.7	83.3
Increase in patient hallucinations			
All participants	58.6	3.4	37.9
Clinicians	69.6	4.3	26.1
Patients	16.7	0	83.3

All participants: n = 29. Clinicians: n = 23. Patients: n = 6

Table 1 Adverse events where majority of patient ratings differ from the whole group

Discussion

In this study, international group of ICU doctors, clinician researchers, and former ICU patients consented on an adverse event tool to assess the safety of physical rehabilitation for patients in critical care.[1] A meta-analysis found that there was not a significant effect of rehabilitation on safety.[3] In contrast, the biggest ICU rehabilitation trial showed that increase in adverse events when intense rehabilitation was compared to normal care.[4]

Conclusion

The adverse event tool can be used in physical rehabilitation studies for ensuring consistent safety assessments. The risk assessment tool can help clinicians determine when start rehabilitation for patients on vasoactive medicines.

References

1. Woodbridge HR, McCarthy CJ, Jones M, Willis M, Antcliffe DB, Alexander CM, Gordon AC. Assessing the safety of physical rehabilitation in critically ill patients: A Delphi study. Crit Care. 2024 Apr 30;28(1):144.
2. Zang K, Chen B, Wang M, Chen D, Hui L, Guo S, Ji T, Shang F. The effect of early mobilization in critically ill patients: a meta-analysis. Nursing in critical care. 2020 Nov;25(6):360-7.
3. Paton M, Chan S, Serpa Neto A, Tipping CJ, Stratton A, Lane R, Romero L, Broadley T, Hodgson CL. Association of active mobilisation variables with adverse events and mortality in patients requiring mechanical ventilation in the intensive care unit: a systematic review and meta-analysis. Lancet Respir Med. 2024 May;12(5):386-398.
4. TEAM Study Investigators and the ANZICS Clinical Trials Group; Hodgson CL, Bailey M, Bellomo R, Brickell K, Broadley T, Buhr H, Gabbe BJ, Gould DW, Harrold M, Higgins AM, Hurford S, Iwashyna TJ, Serpa Neto A, Nichol AD, Presneill JJ, Schaller SJ, Sivasuthan J, Tipping CJ, Webb S, Young PJ. Early Active Mobilization during Mechanical Ventilation in the ICU. N Engl J Med. 2022 Nov 10;387(19):1747-1758.

Critical Rounds
Vol 4 | Issue 45 | 2023

Identification of origin of fungal infections acquired in the intensive care unit using machine learning models

Introduction

The six time-related clinical indicators (arterial catheter, enteral nutrition, corticosteroids, broad-spectrum antibiotics, urine catheter, and invasive mechanical ventilation) are important risk factors for ICU-AF because they offer early detection of fungal infection.

Invasive fungal diseases (IFDs) are fatal infections with rising morbidity and mortality rates. Candida species are the most prevalent microorganisms responsible for IFDs.[1] According to previous study, invasive fungal infections had a mortality rate of more than 30% among critically ill patients. The intensive care unit (ICU) acquired infections had a higher death incidence (461 out of 1706, 27%) compared to community-acquired infections (697 out of 3,474, 20%) and hospital-acquired infections (661 out of 2,724, 24.9%).[2] Studies shown that early and effective antifungal therapy can reduce patient mortality. Diagnosing candidemia requires blood culture, which can be time-consuming and lead to delayed therapy.[1] It is quite challenging for clinical practitioners to correctly confirm and treat ICU-AFI. Therefore, in this study, random forest was used to create and define the predictive model of ICU-AF, or ICU-acquired fungi, in the early stages of fungal infections using machine learning techniques. So, the purpose of this study was to support the management and early detection of fungal infections with evidence.

Methods

This retrospective clinical cohort study analysed data from patients admitted to ICUs who had positive fungal cultures. The ICU-AF group comprised patients with a positive initial culture for fungus more than 48 hours after admission. The Least Absolute Shrinkage and Selection Operator and machine learning were used to create a prediction model of ICU-AF. The model's attributes were then examined for their correlation with illness severity and patient mortality. The correlation between the ICU-AF model, antifungal treatment, and empirical antifungal therapy were examined.

Results

This study included 1,434 patients and employed lasso dimensionality reduction for all aspects and identified six features (arterial catheter times, enteral feeding, corticosteroids, broad spectrum antibiotics, urine catheter, and invasive mechanical ventilation) with relevance ≥0.05 in the optimum model. The model accurately predicted ICU-AF with an area under the curve of 0.981, sensitivity of 0.960, and specificity of 0.990 in the test set. Independent risk variables for antifungal treatment in ICU-AF were the periods of arterial catheterization ($p = 0.011$, OR = 1.057, 95% CI = 1.053–1.104) and invasive mechanical ventilation ($p = 0.007$, OR = 1.056, 95% CI = 1.015–1.098). An independent risk factor for empirical antifungal medication was the arterial catheter times ($p = 0.004$, OR = 1.098, 95%CI = 0.855–0.970) (Table 1).

Critical Rounds
Vol 4 | Issue 45 | 2023

Variable (Times of)	Univariate			Multivariate		
	OR	95%CI	*p* value	OR	95%CI	*p* value
Arterial catheter	1.088	1.035–1.143	0.001	1.098	0.855–0.970	0.004
Invasive mechanical ventilation	1.028	0.987–1.070	0.188	1.053	0.894–1.009	0.094
Urinary catheter	1.018	0.980–1.057	0.362	0.947	0.992–1.125	0.089
Parenteral nutrition	0.99	0.924–1.060	0.769	0.98	0.931–1.118	0.666
Corticosteroids	1.039	0.971–1.111	0.265	1.015	0.910–1.066	0.714
Broad-spectrum antibiotics	1.068	1.007–1.134	0.028	1.052	0.884–1.023	0.176

OR stands for odds ratio, CI for confidence interval; The samples for logistic regression analysis were from all ICU-AF samples with antifungal therapy. Variables were selected with importance ≥ 0.05 in the training set.

Table 1: Independent risk variables for empirical antifungal treatment according to ICU-AF.

Discussion

This study used machine learning(ML) to identify six risk variables (arterial catheter, enteral nutrition, corticosteroids, broad spectrum antibiotics, urinary catheter, and invasive mechanical ventilation) for ICU-AF.[2] Similarly, Siyi Yuan et al. showed that machine learning algorithms can potentially predict candidaemia in the ICU.[1] In another study by Andrea Ripoli et al. Random Forest (RF) accurately predicts the probability of candidemia in patients admitted to internal medical wards (IMWs). Machine learning techniques may help in identifying patients at high risk of candidemia, reducing the time required for empirical therapy, and improving the appropriateness of antifungal prescriptions.[3]

Conclusion

The six time-related clinical parameters (arterial catheter, enteral nutrition, corticosteroids, broad spectrum antibiotics, urinary catheter, and invasive mechanical ventilation) are key risk factors for ICU-AF, as they provide early warning of the occurrence of fungal infection. Additionally, this model can assist ICU physicians in determining whether to treat ICU patients who are prone to fungal infections with empirical antifungal medication.

References

1. Yuan S, Sun Y, Xiao X, Long Y, He H. Using Machine Learning Algorithms to Predict Candidaemia in ICU Patients with New-Onset Systemic Inflammatory Response Syndrome. Front Med (Lausanne). 2021 Aug 19;8:720926.
2. Zhao YS, Lai QP, Tang H, Luo RJ, He ZW, Huang W, Wang LY, Zhang ZT, Lin SH, Qin WJ, Xu F. Identifying the risk factors of ICU-acquired fungal infections: clinical evidence from using machine learning. Front Med (Lausanne). 2024 May 9;11:1386161.
3. Ripoli A, Sozio E, Sbrana F, Bertolino G, Pallotto C, Cardinali G, Meini S, Pieralli F, Azzini AM, Concia E, Viaggi B. Personalized machine learning approach to predict candidemia in medical wards. Infection. 2020 Oct;48:749-59.

Critical Rounds

Vol 4 | Issue 45 | 2023

Critical Rounds
Vol 4 | Issue 45 | 2023

Case report on sudden cardiac arrest in a young person with several arrhythmic substrates

Introduction

In cases of aborted sudden cardiac death, even in cases when the precise etiology was unknown, the primary treatment was secondary prophylaxis with device placement.

Mitral valve prolapse (MVP) is the most common valve disease, affecting around 2.4% of the population. The prevalence and severity of mitral regurgitation (MR) and its complications influence the course of MVP. Therefore, in cases of severe MR, it is usually advised to undergo immediate surgical repair in order to restore life expectancy. In contrast, MVP is regarded as relatively benign in cases of less severe MR and has generally been shown to have an outstanding survival record.[1] MVP is present in 2 to 4% of young people who experience sudden cardiac death (SCD). MVP has a incidence of around 1-3% in the general population, making the mechanism and causes unclear. Although the cause of the ventricular arrhythmias in MVP is unknown, anatomical changes linked to the disease, such as mitral annular disjunction (MAD), may be involved. The posterior mitral valve leaflet insertion must be at least 5 mm distant from the crest of the LV myocardium, to be considered MAD. Transthoracic echo (TTE), transoesophageal echo (TOE), or cardiac CT can all be used to detect MAD; however, cardiac magnetic resonance imaging (CMR) is now the most reliable method.[2] This was a case of 28-year-old man hospitalized after experiencing spontaneous ventricular fibrillation (VF) that resulted in cardiac arrest.

Case Presentation

A 28-year-old man was hospitalized after experiencing spontaneous ventricular fibrillation (VF) that resulted in cardiac arrest outside of the hospital. After receiving bystander CPR (cardiopulmonary resuscitation) and 7 DC shocks, he was able to regain spontaneous circulation. Total downtime was 24 minutes. He was previously healthy, had no cardiac history, was physically fit, and had not used alcohol or recreational drugs before his presentation. His father died suddenly at the age of 50. The patient was extubated 24 hours after admission and recovered completely, with the initial confusion resolved within a few days. The initial 3-lead ECG after ROSC (return of spontaneous circulation) showed diffuse ST-segment depression. Subsequent ECG monitoring revealed multiple arrhythmias, including sinus bradycardia, junctional escape rhythm, polymorphic ventricular ectopics (isolated and self-terminating short runs), and prolonged QTc (472-511 ms). T wave inversion occurred in V2–V4. Figures 1 and 2 show patient ECGs from admission and day 12 after ICD implementation. TTE, TOE, and CMR showed left ventricular dilatation and impairment, with LVEF (left ventricular systolic dysfunction) of 33% (Simpson's). MVP was present, with redundancy of the mitral valve leaflets, moderate mitral regurgitation (MR), and MAD. CMR detected no cardiac inflammation, infarction, infiltration, or fibrosis. Coronary arteries were unblocked during invasive coronary angiography. The patient underwent guideline-directed medical

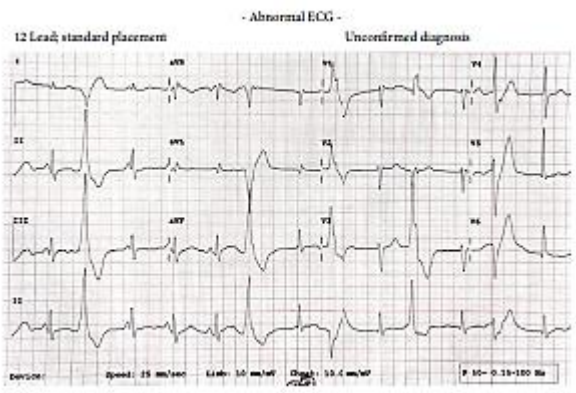

Figure 1: ECG following hospital admission revealing a prolonged QTc and numerous ventricular ectopics.

therapy (GDMT) for LV systolic dysfunction, including spironolactone 25 mg once daily, bisoprolol 2.5 mg twice daily, ramipril 2.5 mg twice daily, and dapagliflozin 10 mg once daily. An ICD (implantable cardioverter defibrillator) was successfully implanted 11 days after admission, and then, he was under outpatient follow-up with the inherited cardiomyopathy team.

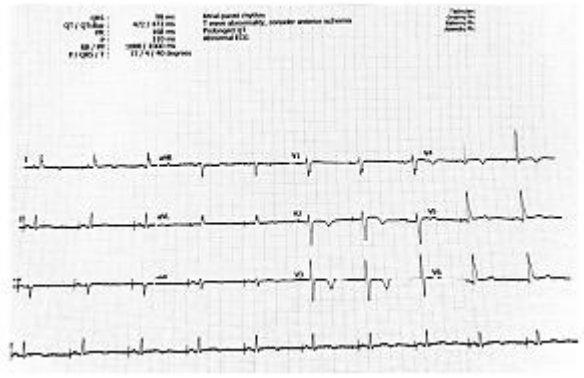

Figure 2: ECG taken on day 12 of hospitalization after ICD installation, displaying a persistent T-wave inversion.

Discussion

This case described a SCD that was aborted in a young adult who had previously shown no symptoms and had many VF substrates, including the recently reported MAD. There was no particular treatment guideline for MAD, thus treatment options are often based on management guidelines for valvular disease, heart failure, and arrhythmias. However, specific care for arrhythmias linked with MVP or MAD remains uncertain.[2] Treatment options include medication, devices (e.g., implanted cardioverter defibrillator), treatments (e.g., ablation), and surgery. For individuals at risk of ventricular arrhythmias, implantation of an ICD was recommended for secondary prevention[3], as demonstrated in this case study.

Conclusion

Mitral valve prolapse with annular disjunction is a growing risk factor for sudden cardiac mortality, although its precise relevance, pathophysiology, and therapy were unknown. Secondary prophylaxis with device installation remains the primary therapy for individuals with aborted sudden cardiac death, even when the specific cause was unknown.

References

1. Essayagh B, Sabbag A, Antoine C, Benfari G, Yang LT, Maalouf J, Asirvatham S, Michelena H, Enriquez-Sarano M. Presentation and outcome of arrhythmic mitral valve prolapse. Journal of the American college of cardiology. 2020 Aug 11;76(6):637-49.
2. Ainsworth J, Ionescu A. Sudden Cardiac Arrest in a Youth with Multiple Arrhythmic Substrates. Case Reports in Critical Care. 2024;2024(1):6054468.
3. Chakrabarti AK, Bogun F, Liang JJ. Arrhythmic Mitral Valve Prolapse and Mitral Annular Disjunction: Clinical Features, Pathophysiology, Risk Stratification, and Management. J Cardiovasc Dev Dis. 2022 Feb 16;9(2):61.