

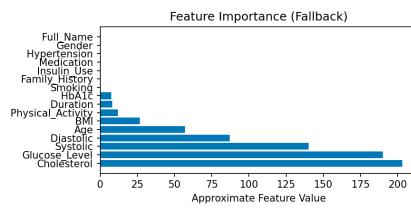
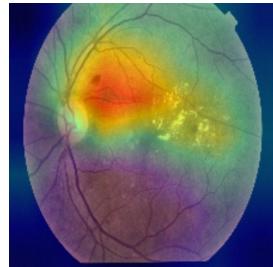
# Research Report

Generated: 2025-12-04 12:14:21

**Stage: MODERATE**

## Metadata Snapshot

Name: zeba  
Age: 57  
Gender: Female  
Systolic (mmHg): 140  
Diastolic (mmHg): 87  
BMI: 26.6  
Glucose: 190  
HbA1c: 7.5  
Cholesterol: 203  
Smoking: No  
Hypertension: Yes  
Diabetes Duration: 8



## Summary

- Research Notes
- UID: 964e30f2
- Predicted stage: MODERATE
- Confidence: 84.61%

# Summary

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- Risk score: 96.32%
- Model stack & inference
  - - CNN ensemble: EfficientNet, ResNet50, ViT
  - - Metadata models: Random Forest, XGBoost, Stacked ensemble
  - - Fusion method: weighted averaging with risk calibration
- - Inference device: CPU
- Explainability & lesion quantification:
  - - Microaneurysms: 26.05%
  - - Exudates: 30.00%
  - - Hemorrhages: 1.80%
  - - Cotton Wool: 0.00%
  - - Neovascularization: 30.00%
  - - Total Lesion Load: 57.85%
- SHAP / feature importance: check SHAP plots for systemic features (HbA1c, BMI, BP).
- Probability vectors:
  - - CNN: [0.006035236641764641, 0.013707426376640797, 0.9612329602241516, 0.010576686821877956, 0.008447720669209957]
  - - ML : [0.21136369507961952, 0.20268235745827803, 0.19376393050773666, 0.19047474400645248, 0.20171527294791336]
  - - Fused: [0.03683450444519308, 0.04205366494029334, 0.8461125836631842, 0.03756139441832536, 0.03743785253300405]
- Performance metrics:
  - - Accuracy: 0.947
  - - F1-score: 0.938
  - - AUC/ROC: 0.971
- Research recommendations:
  - 1. Validate lesion segmentation / cotton-wool detection against annotated masks (report dice/IoU).
  - 2. Add cotton-wool-spot specific augmentation and mask labels if false negatives observed.
  - 3. Measure GradCAM heatmap overlap (IoU) with human heatmaps for explainability calibration.
  - 4. Consider temporal models for progressive DR tracking and early-warning signals.

