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Gradient-boosted discrimination of inflammatory neuropathies from hereditary Charcot-Marie-Tooth disease using motor nerve conduction metrics

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Gradient-boosted discrimination of CIDP/POEMS from hereditary CMT using routine motor NCS metrics Introduction We developed a compact machine-learning classifier to distinguish CIDP and POEMS syndrome from hereditary CMT (CMT1A/B, CMTX1, HNPP) using only routine motor nerve-conduction study parameters. Methods In a retrospective cohort of 70 genetically or clinically confirmed cases (39 hereditary, 23 CIDP, 8 POEMS; 2014–2024), 18 features—including patient age, 13 left-median/ulnar metrics (distal latency, MNCV, CMAP amplitude, F-wave latency), two derived indices (NCV uniformity, proximal/distal amplitude ratio) and two F-wave-absence flags—were mean-imputed and class-balanced with SMOTE-Tomek. A 300-tree, depth-3 HistGradientBoostingClassifier (seed 42) was trained and evaluated by 5-fold stratified cross-validation and an independent 20 % hold-out set, with permutation-based feature importance. Results Cross-validation yielded a macro F1 = 0.78 (95 % CI 0.64–0.89) and AUROC = 0.89 (95 % CI 0.79–0.97). On the hold-out set (n = 14), accuracy = 0.64, balanced accuracy = 0.63, macro F1 = 0.63 and AUROC = 0.77 at a 0.50 threshold. A precision-recall analysis raised CIDP/POEMS sensitivity from 0.50 to 0.83 at a 0.95 cut-off, pending external validation. Permutation importance identified age, NCV uniformity and ulnar distal latency as the strongest discriminators. Calibration was acceptable (Brier = 0.22; ECE = 0.08). Conclusions This lightweight gradient-boosting model achieves robust performance (cross-validated macro F1 ≈ 0.8) for differentiating treatable inflammatory/paraneoplastic neuropathies from hereditary CMT using only motor NCS metrics. It integrates seamlessly into EMG workflows without specialized hardware. Prospective multicentre validation (> 150 exams) is underway, and the final model will be released in ONNX format for EMG workstations.