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Machine learning-based utilization of lipid panels improves the predictability of kidney dysfunction

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Objectives : Dyslipidemia poses a risk for atherosclerotic cardiovascular disease, but its association with kidney dysfunction varies depending on the patient or kidney status. Herein, we used a machine learning model to select lipid panels, aiming to enhance the prediction accuracy of kidney dysfunction.
Methods : 9,403 patients who examined lipid panels, including low-density lipoprotein subfraction scores, were enrolled. The primary outcome was kidney outcome, defined as either a decrease in kidney function by half or the development of end-stage kidney disease. The secondary outcome was the composite outcome, defined as the occurrence of either the kidney outcome or death from any cause. Five machine learning models were utilized to predict outcomes at 1- and 3-year intervals. Feature ranking was used to identify the factors that highly contributed to the model performance.
Results : At 3 years, 117 (1.2%) patients experienced a kidney outcome, while 691 (7.4%) experienced a composite outcome. All models utilizing all features showed high predictive power, achieving an area under the receiver operating characteristics curve exceeding 0.85. When selectively using lipid panels, the multi-layer perceptron and light gradient boosting models demonstrated higher performance in predicting kidney outcome than other models (Table 1). Feature ranking analysis revealed that apolipoprotein A1 and B, as well as low-density lipoprotein cholesterol, were significant contributors to model performance. Grouped analysis of lipid parameters showed their substantial contribution to the 3-year prediction model (Figure 1).
Conclusions : The present machine learning models incorporating lipid panels show success in predicting the risk of kidney dysfunction. This advancement will assist clinicians in precisely identifying patients at risk of kidney dysfunction through the utilization of lipid panels.

ML_Lipid_Table1.png

		Kidney outcome				Composite outcome			
		Model 1		Model 2		Model 1		Model 2	
Models	Outcomes	AUROC	AUPRC	AUROC	AUPRC	AUROC	AUPRC	AUROC	AUPRC
Logistic regression	1 year	0.927	0.399	0.781	0.071	0.878	0.235	0.681	0.094
	2 year	0.919	0.421	0.894	0.219	0.853	0.360	0.709	0.212
	3 year	0.889	0.358	0.787	0.252	0.854	0.423	0.701	0.251
LGBM	1 year	0.828	0.149	0.924	0.184	0.877	0.258	0.704	0.125
	2 year	0.887	0.248	0.886	0.272	0.849	0.384	0.718	0.183
	3 year	0.885	0.358	0.850	0.280	0.860	0.511	0.729	0.285
Random Forest	1 year	0.981	0.373	0.877	0.217	0.869	0.209	0.682	0.098
	2 year	0.967	0.390	0.868	0.327	0.863	0.393	0.733	0.222
	3 year	0.897	0.302	0.847	0.290	0.859	0.449	0.733	0.292
RNN	1 year	0.961	0.347	0.841	0.082	0.867	0.289	0.718	0.117
	2 year	0.946	0.377	0.898	0.241	0.858	0.381	0.756	0.215
	3 year	0.881	0.277	0.861	0.276	0.865	0.455	0.743	0.286
MLP	1 year	0.971	0.441	0.936	0.288	0.887	0.308	0.734	0.141
	2 year	0.967	0.381	0.902	0.262	0.867	0.385	0.760	0.204
	3 year	0.913	0.379	0.874	0.345	0.867	0.485	0.755	0.290

Model 1: all the features are used., Model 2: serum creatinine and lipid panels are used.
AUROC, area under the receiver operating characteristics curve; AUPRC, area under the precision-recall curve; LGBM, light gradient boosting; RNN, recurrent neural network; MLP, multi-layer perceptron.

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