A Retrospective Analysis of Real-World Data: Assessing and Predicting the Cardiovascular Risk Associated with Calcium Channel Blockers in Patients with Hypertension Linke Zou¹, Xingwei Wu², Ming Hu^{1#} ¹West China School of Pharmacy, Sichuan University, Chengdu, China. ²Sichuan Provincial People's Hospital, Chengdu, China.

Background and Objective

- The high incidence and prevalence rates have contributed to hypertension becoming a significant global health concern. The worldwide prevalence of hypertension is steadily increasing and is projected to affect 1.5 billion individuals by 2025. The incidence of cardiovascular events attributable to hypertension remains substantial, imposing a considerable disease burden. Consequently, early assessment of relevant risk factors and implementation of intervention strategies are essential. Calcium channel blockers (CCBs) demonstrate significant efficacy in the management of hypertension and in reducing the incidence of cardiovascular and cerebrovascular events. However, variations in the duration and pharmacokinetic properties of different CCBs result in differing levels of efficacy in preventing major adverse cardiovascular events (MACE).
- **Objective:** To evaluate and predict the preventable cardiovascular risk of calcium channel blockers(CCB) in the treatment of hypertension by analyzing multi-center healthcare data in China.

Methods

- **Data Sources:** Data on inpatients with ≥ 2 hospitalizations treated with CCB from 2019 to 2024 in three medical institutions were analyzed. Utilizing patient IDs and time series information, match the data fields and employ logistic regression analysis to evaluate the effectiveness of various CCB drugs.
- Data Analyses: Data preprocessing involves impute missing values, data oversampling, and feature selection, etc. Nine classification algorithms were used to construct prediction models. The endpoints included major adverse cardiovascular events (MACE), which was assessed at 1 year, 2 years, 3 years. The performance was evaluated using metrics(such as AUC) to select the optimal prediction model.



Figure1 Proportion of outcome indicator classification

Results

• A total of 19374 inpatient data were collected(sample siz: 3854: covariate size: 1843). The proportion of males(55.49%) and patients(59.82%) aged \leq 65 is slightly higher. Coronary heart disease(53%), stroke(31%), and heart failure(11%) were the main outcome events. Logistic regression revealed that observation time, age, and the use of atorvastatin, furosemide, and dexamethasone injections significantly affected cardiovascular risk (P<0.05). The top three most effective CCB among 1165 subgroups are nifedipine sustained-release, controlled-release, and nimodipine tablets, with effectiveness rates of 71.79%, 70.64%, and 65.22%. The CatBoost model excelled in 1 and 2-year CCB cardiovascular risk predictions (AUCs: 0.7978, 0.8289), while the Random Forest model performed the best for 3year. (AUC=0.8329).



Figure 2 The Proportion of patients with outcome events occurring in each follow-up time period

variable	Z	P values	OR,97.5CI
Observation time	15.956	0.001	1.069(1.06-1.078)
Age	9.516	0.001	1.171(1.134-1.21)
Atorvastatin Calcium Tablets	6.769	0.001	1.13(1.091-1.171)
FIB	-3.429	0.001	0.946(0.916-0.976)
Furosemide Injection	2.858	0.004	1.057(1.018-1.099)
Sodium (Na) determination	2.61	0.009	1.05(1.012-1.089)
Determination of Total Calcium	-2.54	0.011	0.954(0.92-0.989)
Dexamethasone Sodium phosphate Injection	-2.345	0.019	0.959(0.927-0.993)
Glucose	2.268	0.023	1.038(1.005-1.072)
Lidocaine Hydrochloride Injection	-2.168	0.03	0.965(0.934-0.997)

RWD91

68%	0760/		
.0070	2.76%	1.40%	0.20%

	2.7070	1.40%	0.20%	
3year	3.5year	4year	4.5year	

ID	Drug Name	Efficient (%)	Sample
1	Nifedipine Sustained Release	71.79	1074
2	Nifedipine Controlled-release	70.64	2129
3	Nimodipine	65.22	23
4	Amlodipine benazepril	65	40
5	Diltiazem Hydrochloride	64.71	51





Figure3 Evaluation index chart of 1-3 year effectiveness prediction model for treatment

Table2 Relative effectiveness of CCB class in the occurrence of cardiovascular events

Conclusion

The data analysis results indicate that the future risk of CVD in hypertensive patients should be taken seriously. The subgroup analysis provide clinical practice references for individualized drug treatment of hypertension patients in China, while machine learning provides assistance in predicting the risk of cardiovascular disease. Risk prediction can mitigate the economic burden associated with cardiovascular complications, which may enhance cost-effectiveness in clinical practice.