

In [7]: *# bert\_baseline\_struct\_full\_metrics\_updated.py*

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import math
import pandas as pd
import torch
import torch.nn as nn
from torch.utils.data import Dataset, DataLoader, random_split
from transformers import AutoTokenizer, AutoModel
from sklearn.preprocessing import StandardScaler
from tqdm import tqdm
from sklearn.metrics import (
    roc_auc_score, accuracy_score, precision_score, recall_score,
    f1_score, matthews_corrcoef, confusion_matrix
)
import matplotlib.pyplot as plt
import gc

# — DATASET WITH STRUCTURED FEATURES —————
class ICUTextStructDataset(Dataset):
    def __init__(self, csv_path, tokenizer_name, max_length, mode='both'):
        df = pd.read_csv(csv_path).reset_index(drop=True)
        # structured columns to include
        self.struct_cols = ['bun', 'calcium', 'creatinine', 'glucose', 'magnesium', 'sod']
        # coerce to numeric, fill missing
        df[self.struct_cols] = (
            df[self.struct_cols]
            .apply(pd.to_numeric, errors='coerce')
            .fillna(0.0)
        )
        # standardize structured features
        scaler = StandardScaler()
        df[self.struct_cols] = scaler.fit_transform(df[self.struct_cols])
        self.data = df

        # tokenizer
        self.tokenizer = AutoTokenizer.from_pretrained(tokenizer_name)
        self.max_length = max_length
        self.mode = mode

    def __len__(self):
        return len(self.data)

    def __getitem__(self, idx):
        row = self.data.iloc[idx]
        text = str(row['text_note'])
        combined = str(row['combined_note'])
        if self.mode == 'text_only':
            full_text = text
        elif self.mode == 'combined_only':
            full_text = combined
        else:
            full_text = text + ' ' + combined

        enc = self.tokenizer(
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        full_text,
        max_length=self.max_length,
        padding='max_length',
        truncation=True,
        return_tensors='pt'
    )
    # build structured features list explicitly as floats
    struct_list = [float(row[c]) for c in self.struct_cols]
    struct_feats = torch.tensor(struct_list, dtype=torch.float32)
    label = torch.tensor(row['mortality_label'], dtype=torch.float32)
    return {
        'input_ids': enc['input_ids'].squeeze(0),
        'attention_mask': enc['attention_mask'].squeeze(0),
        'struct_feats': struct_feats,
        'label': label
    }

# — MODEL WITH STRUCTURED MLP —————
class BERTWithStruct(nn.Module):
    def __init__(self, encoder_name, struct_dim=7, bert_dim=768):
        super().__init__()
        self.encoder = AutoModel.from_pretrained(encoder_name)
        # MLP for structured features
        self.struct_mlp = nn.Sequential(
            nn.Linear(struct_dim, 32),
            nn.ReLU(),
            nn.Linear(32, 32)
        )
        # fusion classifier
        self.classifier = nn.Sequential(
            nn.Linear(bert_dim + 32, 128),
            nn.ReLU(),
            nn.Linear(128, 1)
        )

    def forward(self, input_ids, attention_mask, struct_feats):
        out = self.encoder(input_ids=input_ids, attention_mask=attention_mask)
        cls_emb = out.last_hidden_state[:, 0, :] # (B, bert_dim)
        struct_emb = self.struct_mlp(struct_feats) # (B, 32)
        x = torch.cat([cls_emb, struct_emb], dim=1) # (B, bert_dim + 32)
        return self.classifier(x) # (B,1) logits

# — METRICS CALCULATION —————
def compute_metrics(probs, labels):
    # calibrate threshold to match positive rate
    P = int(sum(labels))
    thr = sorted(probs, reverse=True)[P-1] if P > 0 else 1.0
    preds = [1 if p>=thr else 0 for p in probs]
    tn, fp, fn, tp = confusion_matrix(labels, preds).ravel()
    return {
        'auc': roc_auc_score(labels, probs),
        'accuracy': accuracy_score(labels, preds),
        'precision': precision_score(labels, preds, zero_division=0),
        'recall': recall_score(labels, preds, zero_division=0),
        'f1': f1_score(labels, preds, zero_division=0),
        'mcc': matthews_corrcoef(labels, preds),
    }

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        'specificity': tn/(tn+fp) if (tn+fp)>0 else 0.0,
        'npv': tn/(tn+fn) if (tn+fn)>0 else 0.0,
        'threshold': thr
    }

# — TRAIN & EVAL LOOPS —
def train_epoch(model, loader, device, loss_fn, optimizer):
    model.train()
    total_loss = 0.0
    all_probs, all_labels = [], []
    for batch in tqdm(loader, desc="Train", leave=False):
        ids = batch['input_ids'].to(device)
        mask = batch['attention_mask'].to(device)
        struct = batch['struct_feats'].to(device)
        labels = batch['label'].to(device).unsqueeze(1)

        logits = model(ids, mask, struct)
        loss = loss_fn(logits, labels)
        optimizer.zero_grad()
        loss.backward()
        optimizer.step()
        total_loss += loss.item()

        probs = torch.sigmoid(logits).cpu().squeeze().tolist()
        all_probs.extend(probs if isinstance(probs, list) else [probs])
        all_labels.extend(labels.cpu().squeeze().tolist())

    metrics = compute_metrics(all_probs, all_labels)
    metrics['loss'] = total_loss / len(loader)
    return metrics

def eval_epoch(model, loader, device, loss_fn):
    model.eval()
    total_loss = 0.0
    all_probs, all_labels = [], []
    with torch.no_grad():
        for batch in tqdm(loader, desc="Eval", leave=False):
            ids = batch['input_ids'].to(device)
            mask = batch['attention_mask'].to(device)
            struct = batch['struct_feats'].to(device)
            labels = batch['label'].to(device).unsqueeze(1)

            logits = model(ids, mask, struct)
            loss = loss_fn(logits, labels)
            total_loss += loss.item()

            probs = torch.sigmoid(logits).cpu().squeeze().tolist()
            all_probs.extend(probs if isinstance(probs, list) else [probs])
            all_labels.extend(labels.cpu().squeeze().tolist())

    metrics = compute_metrics(all_probs, all_labels)
    metrics['loss'] = total_loss / len(loader)
    return metrics

# — RUN EXPERIMENT & PLOT —
def run_experiment(model_name="bert-base-uncased", max_length=512, mode_label="both

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ds = ICUTextStructDataset("final.csv", model_name, max_length, mode_label)
n = len(ds)
train_n = int(0.8 * n)
train_ds, val_ds = random_split(ds, [train_n, n - train_n])

train_loader = DataLoader(train_ds, batch_size=4, shuffle=True)
val_loader = DataLoader(val_ds, batch_size=4, shuffle=False)

device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
model = BERTWithStruct(model_name).to(device)

# compute pos_weight for imbalance
train_labels = [ds[i]['label'].item() for i in train_ds.indices]
neg, pos = train_labels.count(0), train_labels.count(1)
pos_weight = torch.tensor([(neg/pos) if pos>0 else 1.0], device=device)
loss_fn = nn.BCEWithLogitsLoss(pos_weight=pos_weight)
optimizer = torch.optim.AdamW(model.parameters(), lr=1e-4)

epochs = 100
keys = ['loss', 'auc', 'accuracy', 'precision', 'recall', 'f1', 'mcc', 'specificity', '']
hist_tr = {k: [] for k in keys}
hist_val = {k: [] for k in keys}

for epoch in range(1, epochs+1):
    print(f"\nEpoch {epoch}/{epochs}")
    m_tr = train_epoch(model, train_loader, device, loss_fn, optimizer)
    m_val = eval_epoch(model, val_loader, device, loss_fn)
    for k in keys:
        hist_tr[k].append(m_tr[k])
        hist_val[k].append(m_val[k])
    # print full metrics
    summary_tr = {k: f"{m_tr[k]:.4f}" for k in keys}
    summary_val = {k: f"{m_val[k]:.4f}" for k in keys}
    print(" Train:", summary_tr)
    print(" Val: ", summary_val)

# plotting selected metrics
plt.figure(figsize=(14,10))
for i, metric in enumerate(['auc', 'accuracy', 'precision', 'recall', 'f1', 'mcc'], 1):
    plt.subplot(3,3,i)
    plt.plot(hist_tr[metric], label="Train")
    plt.plot(hist_val[metric], label="Val")
    plt.title(metric)
    plt.legend()
plt.tight_layout()
plt.show()

# cleanup
del model
torch.cuda.empty_cache()
gc.collect()

```

In [8]: run\_experiment()

Epoch 1/100

Train: {'loss': '1.3439', 'auc': '0.4815', 'accuracy': '0.8513', 'precision': '0.0143', 'recall': '0.0143', 'f1': '0.0143', 'mcc': '-0.0661', 'specificity': '0.9196', 'npv': '0.9196', 'threshold': '0.5471'}

Val: {'loss': '1.3792', 'auc': '0.7942', 'accuracy': '0.8793', 'precision': '0.3333', 'recall': '0.3333', 'f1': '0.3333', 'mcc': '0.2670', 'specificity': '0.9336', 'npv': '0.9336', 'threshold': '0.5544'}

Epoch 2/100

Train: {'loss': '1.2750', 'auc': '0.5785', 'accuracy': '0.8685', 'precision': '0.1286', 'recall': '0.1286', 'f1': '0.1286', 'mcc': '0.0575', 'specificity': '0.9289', 'npv': '0.9289', 'threshold': '0.5515'}

Val: {'loss': '1.4868', 'auc': '0.7944', 'accuracy': '0.8793', 'precision': '0.3333', 'recall': '0.3333', 'f1': '0.3333', 'mcc': '0.2670', 'specificity': '0.9336', 'npv': '0.9336', 'threshold': '0.3915'}

Epoch 3/100

Train: {'loss': '1.2777', 'auc': '0.5823', 'accuracy': '0.8707', 'precision': '0.1429', 'recall': '0.1429', 'f1': '0.1429', 'mcc': '0.0729', 'specificity': '0.9301', 'npv': '0.9301', 'threshold': '0.5442'}

Val: {'loss': '1.3384', 'auc': '0.7831', 'accuracy': '0.8793', 'precision': '0.3333', 'recall': '0.3333', 'f1': '0.3333', 'mcc': '0.2670', 'specificity': '0.9336', 'npv': '0.9336', 'threshold': '0.5422'}

Epoch 4/100

Train: {'loss': '1.2254', 'auc': '0.6807', 'accuracy': '0.8858', 'precision': '0.2429', 'recall': '0.2429', 'f1': '0.2429', 'mcc': '0.1811', 'specificity': '0.9382', 'npv': '0.9382', 'threshold': '0.5590'}

Val: {'loss': '1.2969', 'auc': '0.7840', 'accuracy': '0.8793', 'precision': '0.3333', 'recall': '0.3333', 'f1': '0.3333', 'mcc': '0.2670', 'specificity': '0.9336', 'npv': '0.9336', 'threshold': '0.5734'}

Epoch 5/100

Train: {'loss': '1.1840', 'auc': '0.7141', 'accuracy': '0.8987', 'precision': '0.3286', 'recall': '0.3286', 'f1': '0.3286', 'mcc': '0.2738', 'specificity': '0.9452', 'npv': '0.9452', 'threshold': '0.5778'}

Val: {'loss': '1.2388', 'auc': '0.7854', 'accuracy': '0.8793', 'precision': '0.3333', 'recall': '0.3333', 'f1': '0.3333', 'mcc': '0.2670', 'specificity': '0.9336', 'npv': '0.9336', 'threshold': '0.6428'}

Epoch 6/100

Train: {'loss': '1.1429', 'auc': '0.7361', 'accuracy': '0.8987', 'precision': '0.3286', 'recall': '0.3286', 'f1': '0.3286', 'mcc': '0.2738', 'specificity': '0.9452', 'npv': '0.9452', 'threshold': '0.6294'}

Val: {'loss': '1.2147', 'auc': '0.7926', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.6196'}

Epoch 7/100

Train: {'loss': '1.1115', 'auc': '0.7430', 'accuracy': '0.9009', 'precision': '0.3429', 'recall': '0.3429', 'f1': '0.3429', 'mcc': '0.2892', 'specificity': '0.9464', 'npv': '0.9464', 'threshold': '0.6331'}  
Val: {'loss': '1.1660', 'auc': '0.7942', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.7268'}

Epoch 8/100

Train: {'loss': '1.0927', 'auc': '0.7498', 'accuracy': '0.9009', 'precision': '0.3429', 'recall': '0.3429', 'f1': '0.3429', 'mcc': '0.2892', 'specificity': '0.9464', 'npv': '0.9464', 'threshold': '0.6869'}  
Val: {'loss': '1.1706', 'auc': '0.8025', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.6630'}

Epoch 9/100

Train: {'loss': '1.0696', 'auc': '0.7728', 'accuracy': '0.8987', 'precision': '0.3286', 'recall': '0.3286', 'f1': '0.3286', 'mcc': '0.2738', 'specificity': '0.9452', 'npv': '0.9452', 'threshold': '0.7135'}  
Val: {'loss': '1.1764', 'auc': '0.8088', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.6422'}

Epoch 10/100

Train: {'loss': '1.0614', 'auc': '0.7663', 'accuracy': '0.9073', 'precision': '0.3857', 'recall': '0.3857', 'f1': '0.3857', 'mcc': '0.3356', 'specificity': '0.9499', 'npv': '0.9499', 'threshold': '0.6914'}  
Val: {'loss': '1.1236', 'auc': '0.8118', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.7059'}

Epoch 11/100

Train: {'loss': '1.0474', 'auc': '0.7734', 'accuracy': '0.9052', 'precision': '0.3714', 'recall': '0.3714', 'f1': '0.3714', 'mcc': '0.3201', 'specificity': '0.9487', 'npv': '0.9487', 'threshold': '0.6998'}  
Val: {'loss': '1.1003', 'auc': '0.8165', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8214'}

Epoch 12/100

Train: {'loss': '1.0353', 'auc': '0.7845', 'accuracy': '0.9073', 'precision': '0.3857', 'recall': '0.3857', 'f1': '0.3857', 'mcc': '0.3356', 'specificity': '0.9499', 'npv': '0.9499', 'threshold': '0.7344'}  
Val: {'loss': '1.0718', 'auc': '0.8215', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.7837'}

Epoch 13/100

Train: {'loss': '1.0240', 'auc': '0.7911', 'accuracy': '0.9073', 'precision': '0.3857', 'recall': '0.3857', 'f1': '0.3857', 'mcc': '0.3356', 'specificity': '0.9499', 'npv': '0.9499', 'threshold': '0.7344'}

Val: {'loss': '1.0689', 'auc': '0.8283', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.7552'}

Epoch 14/100

Train: {'loss': '1.0183', 'auc': '0.7978', 'accuracy': '0.9095', 'precision': '0.4000', 'recall': '0.4000', 'f1': '0.4000', 'mcc': '0.3510', 'specificity': '0.9510', 'npv': '0.9510', 'threshold': '0.7271'}

Val: {'loss': '1.0519', 'auc': '0.8348', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.7635'}

Epoch 15/100

Train: {'loss': '1.0069', 'auc': '0.7996', 'accuracy': '0.9095', 'precision': '0.4000', 'recall': '0.4000', 'f1': '0.4000', 'mcc': '0.3510', 'specificity': '0.9510', 'npv': '0.9510', 'threshold': '0.7311'}

Val: {'loss': '1.0313', 'auc': '0.8382', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8054'}

Epoch 16/100

Train: {'loss': '0.9967', 'auc': '0.8080', 'accuracy': '0.9073', 'precision': '0.3857', 'recall': '0.3857', 'f1': '0.3857', 'mcc': '0.3356', 'specificity': '0.9499', 'npv': '0.9499', 'threshold': '0.7411'}

Val: {'loss': '1.0270', 'auc': '0.8413', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8281'}

Epoch 17/100

Train: {'loss': '0.9823', 'auc': '0.8154', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.7411'}

Val: {'loss': '1.0149', 'auc': '0.8452', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.7770'}

Epoch 18/100

Train: {'loss': '0.9855', 'auc': '0.8122', 'accuracy': '0.9073', 'precision': '0.3857', 'recall': '0.3857', 'f1': '0.3857', 'mcc': '0.3356', 'specificity': '0.9499', 'npv': '0.9499', 'threshold': '0.7590'}

Val: {'loss': '1.0019', 'auc': '0.8486', 'accuracy': '0.9052', 'precision': '0.4762', 'recall': '0.4762', 'f1': '0.4762', 'mcc': '0.4241', 'specificity': '0.9479', 'npv': '0.9479', 'threshold': '0.8060'}

Epoch 19/100

Train: {'loss': '0.9687', 'auc': '0.8219', 'accuracy': '0.9052', 'precision': '0.3714', 'recall': '0.3714', 'f1': '0.3714', 'mcc': '0.3201', 'specificity': '0.9487', 'npv': '0.9487', 'threshold': '0.7544'}

Val: {'loss': '0.9916', 'auc': '0.8499', 'accuracy': '0.9052', 'precision': '0.4762', 'recall': '0.4762', 'f1': '0.4762', 'mcc': '0.4241', 'specificity': '0.9479', 'npv': '0.9479', 'threshold': '0.8191'}

Epoch 20/100

Train: {'loss': '0.9561', 'auc': '0.8303', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.7737'}

Val: {'loss': '0.9929', 'auc': '0.8524', 'accuracy': '0.9052', 'precision': '0.4762', 'recall': '0.4762', 'f1': '0.4762', 'mcc': '0.4241', 'specificity': '0.9479', 'npv': '0.9479', 'threshold': '0.7502'}

Epoch 21/100

Train: {'loss': '0.9440', 'auc': '0.8353', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.7604'}

Val: {'loss': '0.9795', 'auc': '0.8535', 'accuracy': '0.9052', 'precision': '0.4762', 'recall': '0.4762', 'f1': '0.4762', 'mcc': '0.4241', 'specificity': '0.9479', 'npv': '0.9479', 'threshold': '0.8193'}

Epoch 22/100

Train: {'loss': '0.9488', 'auc': '0.8320', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.7747'}

Val: {'loss': '0.9700', 'auc': '0.8551', 'accuracy': '0.9052', 'precision': '0.4762', 'recall': '0.4762', 'f1': '0.4762', 'mcc': '0.4241', 'specificity': '0.9479', 'npv': '0.9479', 'threshold': '0.7861'}

Epoch 23/100

Train: {'loss': '0.9218', 'auc': '0.8420', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.7826'}

Val: {'loss': '0.9690', 'auc': '0.8571', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8322'}

Epoch 24/100

Train: {'loss': '0.9261', 'auc': '0.8401', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.7513'}

Val: {'loss': '0.9875', 'auc': '0.8578', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8627'}

Epoch 25/100



Train: {'loss': '0.9155', 'auc': '0.8424', 'accuracy': '0.9073', 'precision': '0.3857', 'recall': '0.3857', 'f1': '0.3857', 'mcc': '0.3356', 'specificity': '0.9499', 'npv': '0.9499', 'threshold': '0.7832'}  
Val: {'loss': '0.9702', 'auc': '0.8580', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8581'}

Epoch 26/100

Train: {'loss': '0.9037', 'auc': '0.8495', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.7997'}  
Val: {'loss': '0.9503', 'auc': '0.8589', 'accuracy': '0.9052', 'precision': '0.4762', 'recall': '0.4762', 'f1': '0.4762', 'mcc': '0.4241', 'specificity': '0.9479', 'npv': '0.9479', 'threshold': '0.8105'}

Epoch 27/100

Train: {'loss': '0.8997', 'auc': '0.8501', 'accuracy': '0.9095', 'precision': '0.4000', 'recall': '0.4000', 'f1': '0.4000', 'mcc': '0.3510', 'specificity': '0.9510', 'npv': '0.9510', 'threshold': '0.7735'}  
Val: {'loss': '0.9407', 'auc': '0.8632', 'accuracy': '0.9052', 'precision': '0.4762', 'recall': '0.4762', 'f1': '0.4762', 'mcc': '0.4241', 'specificity': '0.9479', 'npv': '0.9479', 'threshold': '0.8361'}

Epoch 28/100

Train: {'loss': '0.8950', 'auc': '0.8508', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.7912'}  
Val: {'loss': '0.9420', 'auc': '0.8614', 'accuracy': '0.9052', 'precision': '0.4762', 'recall': '0.4762', 'f1': '0.4762', 'mcc': '0.4241', 'specificity': '0.9479', 'npv': '0.9479', 'threshold': '0.8469'}

Epoch 29/100

Train: {'loss': '0.8815', 'auc': '0.8564', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.7885'}  
Val: {'loss': '0.9405', 'auc': '0.8623', 'accuracy': '0.9052', 'precision': '0.4762', 'recall': '0.4762', 'f1': '0.4762', 'mcc': '0.4241', 'specificity': '0.9479', 'npv': '0.9479', 'threshold': '0.8543'}

Epoch 30/100

Train: {'loss': '0.8816', 'auc': '0.8553', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.7863'}  
Val: {'loss': '0.9373', 'auc': '0.8612', 'accuracy': '0.9052', 'precision': '0.4762', 'recall': '0.4762', 'f1': '0.4762', 'mcc': '0.4241', 'specificity': '0.9479', 'npv': '0.9479', 'threshold': '0.8529'}

Epoch 31/100

Train: {'loss': '0.8759', 'auc': '0.8572', 'accuracy': '0.9073', 'precision': '0.3857', 'recall': '0.3857', 'f1': '0.3857', 'mcc': '0.3356', 'specificity': '0.9499', 'npv': '0.9499', 'threshold': '0.7945'}

Val: {'loss': '0.9358', 'auc': '0.8626', 'accuracy': '0.9052', 'precision': '0.4762', 'recall': '0.4762', 'f1': '0.4762', 'mcc': '0.4241', 'specificity': '0.9479', 'npv': '0.9479', 'threshold': '0.8509'}

Epoch 32/100

Train: {'loss': '0.8662', 'auc': '0.8612', 'accuracy': '0.9073', 'precision': '0.3857', 'recall': '0.3857', 'f1': '0.3857', 'mcc': '0.3356', 'specificity': '0.9499', 'npv': '0.9499', 'threshold': '0.7858'}

Val: {'loss': '0.9351', 'auc': '0.8614', 'accuracy': '0.9052', 'precision': '0.4762', 'recall': '0.4762', 'f1': '0.4762', 'mcc': '0.4241', 'specificity': '0.9479', 'npv': '0.9479', 'threshold': '0.8437'}

Epoch 33/100

Train: {'loss': '0.8607', 'auc': '0.8614', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.7904'}

Val: {'loss': '0.9370', 'auc': '0.8621', 'accuracy': '0.9138', 'precision': '0.5238', 'recall': '0.5238', 'f1': '0.5238', 'mcc': '0.4764', 'specificity': '0.9526', 'npv': '0.9526', 'threshold': '0.8655'}

Epoch 34/100

Train: {'loss': '0.8488', 'auc': '0.8666', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.8039'}

Val: {'loss': '0.9348', 'auc': '0.8614', 'accuracy': '0.9052', 'precision': '0.4762', 'recall': '0.4762', 'f1': '0.4762', 'mcc': '0.4241', 'specificity': '0.9479', 'npv': '0.9479', 'threshold': '0.8571'}

Epoch 35/100

Train: {'loss': '0.8504', 'auc': '0.8642', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.7825'}

Val: {'loss': '0.9341', 'auc': '0.8614', 'accuracy': '0.9052', 'precision': '0.4762', 'recall': '0.4762', 'f1': '0.4762', 'mcc': '0.4241', 'specificity': '0.9479', 'npv': '0.9479', 'threshold': '0.8529'}

Epoch 36/100

Train: {'loss': '0.8397', 'auc': '0.8683', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.7824'}

Val: {'loss': '0.9328', 'auc': '0.8628', 'accuracy': '0.9138', 'precision': '0.5238', 'recall': '0.5238', 'f1': '0.5238', 'mcc': '0.4764', 'specificity': '0.9526', 'npv': '0.9526', 'threshold': '0.8598'}

Epoch 37/100

Train: {'loss': '0.8225', 'auc': '0.8752', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.7856'}  
Val: {'loss': '0.9370', 'auc': '0.8617', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8862'}

Epoch 38/100

Train: {'loss': '0.8231', 'auc': '0.8748', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8025'}  
Val: {'loss': '0.9443', 'auc': '0.8601', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8436'}

Epoch 39/100

Train: {'loss': '0.8303', 'auc': '0.8728', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.8111'}  
Val: {'loss': '0.9345', 'auc': '0.8594', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8601'}

Epoch 40/100

Train: {'loss': '0.8080', 'auc': '0.8795', 'accuracy': '0.9095', 'precision': '0.4000', 'recall': '0.4000', 'f1': '0.4000', 'mcc': '0.3510', 'specificity': '0.9510', 'npv': '0.9510', 'threshold': '0.7915'}  
Val: {'loss': '0.9336', 'auc': '0.8603', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8667'}

Epoch 41/100

Train: {'loss': '0.8192', 'auc': '0.8749', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.8078'}  
Val: {'loss': '0.9361', 'auc': '0.8585', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8611'}

Epoch 42/100

Train: {'loss': '0.8121', 'auc': '0.8764', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.7890'}  
Val: {'loss': '0.9354', 'auc': '0.8596', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8649'}

Epoch 43/100

Train: {'loss': '0.8129', 'auc': '0.8758', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.7959'}  
Val: {'loss': '0.9433', 'auc': '0.8603', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8481'}

Epoch 44/100

Train: {'loss': '0.7997', 'auc': '0.8799', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.7955'}  
Val: {'loss': '0.9523', 'auc': '0.8580', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8463'}

Epoch 45/100

Train: {'loss': '0.7934', 'auc': '0.8817', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.7967'}  
Val: {'loss': '0.9940', 'auc': '0.8569', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8215'}

Epoch 46/100

Train: {'loss': '0.7938', 'auc': '0.8813', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8021'}  
Val: {'loss': '0.9518', 'auc': '0.8578', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8921'}

Epoch 47/100

Train: {'loss': '0.7871', 'auc': '0.8857', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.8020'}  
Val: {'loss': '0.9514', 'auc': '0.8571', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8504'}

Epoch 48/100

Train: {'loss': '0.7999', 'auc': '0.8791', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.8034'}  
Val: {'loss': '0.9478', 'auc': '0.8569', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8636'}

Epoch 49/100

Train: {'loss': '0.7864', 'auc': '0.8853', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.7967'}  
Val: {'loss': '0.9491', 'auc': '0.8574', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8635'}

Epoch 50/100

Train: {'loss': '0.7826', 'auc': '0.8859', 'accuracy': '0.9181', 'precision': '0.4571', 'recall': '0.4571', 'f1': '0.4571', 'mcc': '0.4129', 'specificity': '0.9557', 'npv': '0.9557', 'threshold': '0.8093'}  
Val: {'loss': '0.9482', 'auc': '0.8565', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8723'}

Epoch 51/100

Train: {'loss': '0.7681', 'auc': '0.8916', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.8082'}  
Val: {'loss': '0.9823', 'auc': '0.8569', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8327'}

Epoch 52/100

Train: {'loss': '0.7783', 'auc': '0.8867', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.8136'}  
Val: {'loss': '0.9729', 'auc': '0.8565', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8389'}

Epoch 53/100

Train: {'loss': '0.7788', 'auc': '0.8864', 'accuracy': '0.9181', 'precision': '0.4571', 'recall': '0.4571', 'f1': '0.4571', 'mcc': '0.4129', 'specificity': '0.9557', 'npv': '0.9557', 'threshold': '0.8099'}  
Val: {'loss': '0.9580', 'auc': '0.8558', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8658'}

Epoch 54/100

Train: {'loss': '0.7684', 'auc': '0.8907', 'accuracy': '0.9181', 'precision': '0.4571', 'recall': '0.4571', 'f1': '0.4571', 'mcc': '0.4129', 'specificity': '0.9557', 'npv': '0.9557', 'threshold': '0.8123'}  
Val: {'loss': '0.9617', 'auc': '0.8538', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8600'}

Epoch 55/100

Train: {'loss': '0.7601', 'auc': '0.8930', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.8030'}

Val: {'loss': '0.9667', 'auc': '0.8535', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8633'}

Epoch 56/100

Train: {'loss': '0.7644', 'auc': '0.8911', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.8019'}

Val: {'loss': '0.9621', 'auc': '0.8531', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8805'}

Epoch 57/100

Train: {'loss': '0.7550', 'auc': '0.8939', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.8205'}

Val: {'loss': '0.9925', 'auc': '0.8526', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8420'}

Epoch 58/100

Train: {'loss': '0.7619', 'auc': '0.8919', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.7997'}

Val: {'loss': '0.9694', 'auc': '0.8499', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8580'}

Epoch 59/100

Train: {'loss': '0.7545', 'auc': '0.8934', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.8129'}

Val: {'loss': '0.9694', 'auc': '0.8492', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8728'}

Epoch 60/100

Train: {'loss': '0.7556', 'auc': '0.8934', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8212'}

Val: {'loss': '0.9876', 'auc': '0.8492', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8556'}

Epoch 61/100

Train: {'loss': '0.7546', 'auc': '0.8940', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.8131'}

Val: {'loss': '0.9968', 'auc': '0.8486', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8563'}

Epoch 62/100

Train: {'loss': '0.7643', 'auc': '0.8913', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8070'}

Val: {'loss': '0.9731', 'auc': '0.8474', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8887'}

Epoch 63/100

Train: {'loss': '0.7488', 'auc': '0.8966', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8227'}

Val: {'loss': '0.9962', 'auc': '0.8472', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8634'}

Epoch 64/100

Train: {'loss': '0.7398', 'auc': '0.8982', 'accuracy': '0.9095', 'precision': '0.4000', 'recall': '0.4000', 'f1': '0.4000', 'mcc': '0.3510', 'specificity': '0.9510', 'npv': '0.9510', 'threshold': '0.8203'}

Val: {'loss': '0.9903', 'auc': '0.8456', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8695'}

Epoch 65/100

Train: {'loss': '0.7275', 'auc': '0.9017', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.8108'}

Val: {'loss': '0.9836', 'auc': '0.8468', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8996'}

Epoch 66/100

Train: {'loss': '0.7417', 'auc': '0.8983', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.8242'}

Val: {'loss': '1.0145', 'auc': '0.8454', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8650'}

Epoch 67/100

Train: {'loss': '0.7419', 'auc': '0.8987', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.8213'}

Val: {'loss': '0.9834', 'auc': '0.8443', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8908'}

Epoch 68/100

Train: {'loss': '0.7406', 'auc': '0.8981', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.8332'}

Val: {'loss': '1.0111', 'auc': '0.8432', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8795'}

Epoch 69/100

Train: {'loss': '0.7496', 'auc': '0.8942', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.8242'}

Val: {'loss': '1.0054', 'auc': '0.8411', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8822'}

Epoch 70/100

Train: {'loss': '0.7381', 'auc': '0.8996', 'accuracy': '0.9181', 'precision': '0.4571', 'recall': '0.4571', 'f1': '0.4571', 'mcc': '0.4129', 'specificity': '0.9557', 'npv': '0.9557', 'threshold': '0.8378'}

Val: {'loss': '1.0163', 'auc': '0.8404', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8792'}

Epoch 71/100

Train: {'loss': '0.7281', 'auc': '0.9016', 'accuracy': '0.9181', 'precision': '0.4571', 'recall': '0.4571', 'f1': '0.4571', 'mcc': '0.4129', 'specificity': '0.9557', 'npv': '0.9557', 'threshold': '0.8207'}

Val: {'loss': '1.0180', 'auc': '0.8400', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8831'}

Epoch 72/100

Train: {'loss': '0.7211', 'auc': '0.9031', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8299'}

Val: {'loss': '1.0314', 'auc': '0.8416', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8703'}

Epoch 73/100



Train: {'loss': '0.7234', 'auc': '0.9030', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8190'}

Val: {'loss': '0.9986', 'auc': '0.8404', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8896'}

Epoch 74/100

Train: {'loss': '0.7103', 'auc': '0.9064', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8375'}

Val: {'loss': '1.0432', 'auc': '0.8407', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8631'}

Epoch 75/100

Train: {'loss': '0.7218', 'auc': '0.9037', 'accuracy': '0.9181', 'precision': '0.4571', 'recall': '0.4571', 'f1': '0.4571', 'mcc': '0.4129', 'specificity': '0.9557', 'npv': '0.9557', 'threshold': '0.8172'}

Val: {'loss': '1.0714', 'auc': '0.8395', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8631'}

Epoch 76/100

Train: {'loss': '0.7244', 'auc': '0.9034', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.7930'}

Val: {'loss': '1.0162', 'auc': '0.8386', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.9061'}

Epoch 77/100

Train: {'loss': '0.6897', 'auc': '0.9135', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8572'}

Val: {'loss': '1.1956', 'auc': '0.8391', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8201'}

Epoch 78/100

Train: {'loss': '0.7219', 'auc': '0.9038', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.8170'}

Val: {'loss': '1.0441', 'auc': '0.8384', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8822'}

Epoch 79/100

Train: {'loss': '0.7145', 'auc': '0.9045', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8197'}  
Val: {'loss': '1.0364', 'auc': '0.8373', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8905'}

Epoch 80/100

Train: {'loss': '0.6993', 'auc': '0.9089', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.8119'}  
Val: {'loss': '1.0317', 'auc': '0.8366', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.9036'}

Epoch 81/100

Train: {'loss': '0.7095', 'auc': '0.9064', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8308'}  
Val: {'loss': '1.0381', 'auc': '0.8339', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8949'}

Epoch 82/100

Train: {'loss': '0.7207', 'auc': '0.9040', 'accuracy': '0.9203', 'precision': '0.4714', 'recall': '0.4714', 'f1': '0.4714', 'mcc': '0.4283', 'specificity': '0.9569', 'npv': '0.9569', 'threshold': '0.8254'}  
Val: {'loss': '1.0508', 'auc': '0.8334', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8874'}

Epoch 83/100

Train: {'loss': '0.7032', 'auc': '0.9081', 'accuracy': '0.9181', 'precision': '0.4571', 'recall': '0.4571', 'f1': '0.4571', 'mcc': '0.4129', 'specificity': '0.9557', 'npv': '0.9557', 'threshold': '0.8357'}  
Val: {'loss': '1.0388', 'auc': '0.8375', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8855'}

Epoch 84/100

Train: {'loss': '0.6956', 'auc': '0.9106', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8384'}  
Val: {'loss': '1.1027', 'auc': '0.8339', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8647'}

Epoch 85/100

Train: {'loss': '0.7086', 'auc': '0.9067', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.8351'}  
Val: {'loss': '1.0888', 'auc': '0.8341', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8721'}

Epoch 86/100

Train: {'loss': '0.7021', 'auc': '0.9090', 'accuracy': '0.9116', 'precision': '0.4143', 'recall': '0.4143', 'f1': '0.4143', 'mcc': '0.3665', 'specificity': '0.9522', 'npv': '0.9522', 'threshold': '0.8196'}  
Val: {'loss': '1.0732', 'auc': '0.8366', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8864'}

Epoch 87/100

Train: {'loss': '0.7103', 'auc': '0.9058', 'accuracy': '0.9181', 'precision': '0.4571', 'recall': '0.4571', 'f1': '0.4571', 'mcc': '0.4129', 'specificity': '0.9557', 'npv': '0.9557', 'threshold': '0.8282'}  
Val: {'loss': '1.0673', 'auc': '0.8328', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8883'}

Epoch 88/100

Train: {'loss': '0.6939', 'auc': '0.9107', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8317'}  
Val: {'loss': '1.0794', 'auc': '0.8334', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8847'}

Epoch 89/100

Train: {'loss': '0.6926', 'auc': '0.9113', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8179'}  
Val: {'loss': '1.0523', 'auc': '0.8339', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.9061'}

Epoch 90/100

Train: {'loss': '0.6995', 'auc': '0.9098', 'accuracy': '0.9138', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3820', 'specificity': '0.9534', 'npv': '0.9534', 'threshold': '0.8366'}  
Val: {'loss': '1.0939', 'auc': '0.8321', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8808'}

Epoch 91/100

Train: {'loss': '0.6916', 'auc': '0.9116', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8272'}

Val: {'loss': '1.1460', 'auc': '0.8301', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8649'}

Epoch 92/100

Train: {'loss': '0.6907', 'auc': '0.9115', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8402'}

Val: {'loss': '1.1260', 'auc': '0.8298', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8711'}

Epoch 93/100

Train: {'loss': '0.6881', 'auc': '0.9115', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8277'}

Val: {'loss': '1.1125', 'auc': '0.8301', 'accuracy': '0.8966', 'precision': '0.4286', 'recall': '0.4286', 'f1': '0.4286', 'mcc': '0.3717', 'specificity': '0.9431', 'npv': '0.9431', 'threshold': '0.8904'}

Epoch 94/100

Train: {'loss': '0.6966', 'auc': '0.9095', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8397'}

Val: {'loss': '1.0995', 'auc': '0.8285', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8848'}

Epoch 95/100

Train: {'loss': '0.6822', 'auc': '0.9143', 'accuracy': '0.9224', 'precision': '0.4857', 'recall': '0.4857', 'f1': '0.4857', 'mcc': '0.4438', 'specificity': '0.9580', 'npv': '0.9580', 'threshold': '0.8317'}

Val: {'loss': '1.0974', 'auc': '0.8262', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8964'}

Epoch 96/100

Train: {'loss': '0.6843', 'auc': '0.9124', 'accuracy': '0.9181', 'precision': '0.4571', 'recall': '0.4571', 'f1': '0.4571', 'mcc': '0.4129', 'specificity': '0.9557', 'npv': '0.9557', 'threshold': '0.8285'}

Val: {'loss': '1.1018', 'auc': '0.8246', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8949'}

Epoch 97/100

```
Train: {'loss': '0.6838', 'auc': '0.9129', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8326'}
Val:   {'loss': '1.1131', 'auc': '0.8244', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8930'}
```

Epoch 98/100

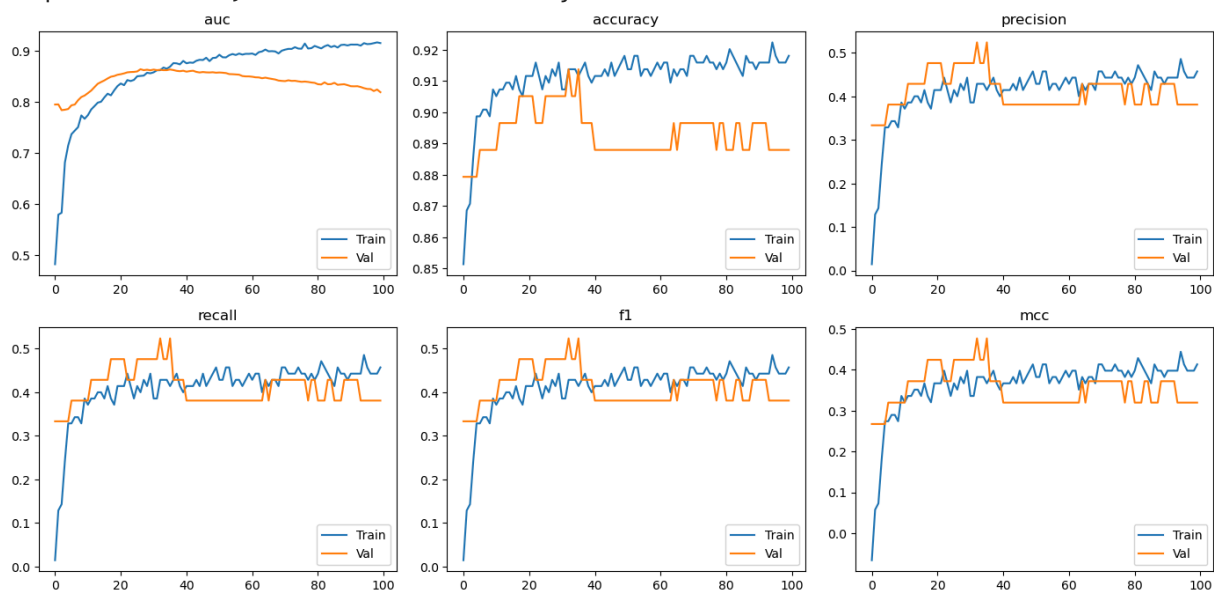
```
Train: {'loss': '0.6794', 'auc': '0.9143', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8366'}
Val:   {'loss': '1.1312', 'auc': '0.8206', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8854'}
```

Epoch 99/100

```
Train: {'loss': '0.6748', 'auc': '0.9159', 'accuracy': '0.9159', 'precision': '0.4429', 'recall': '0.4429', 'f1': '0.4429', 'mcc': '0.3974', 'specificity': '0.9545', 'npv': '0.9545', 'threshold': '0.8239'}
Val:   {'loss': '1.1029', 'auc': '0.8235', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8971'}
```

Epoch 100/100

```
Train: {'loss': '0.6754', 'auc': '0.9145', 'accuracy': '0.9181', 'precision': '0.4571', 'recall': '0.4571', 'f1': '0.4571', 'mcc': '0.4129', 'specificity': '0.9557', 'npv': '0.9557', 'threshold': '0.8412'}
Val:   {'loss': '1.1337', 'auc': '0.8183', 'accuracy': '0.8879', 'precision': '0.3810', 'recall': '0.3810', 'f1': '0.3810', 'mcc': '0.3193', 'specificity': '0.9384', 'npv': '0.9384', 'threshold': '0.8905'}
```



In [ ]: