**Medication Error Risk Intelligence & Forecasting Analysis**

**Executive Summary**

**Findings and Analysis**

A total of **558 medication error reports** spanning six GMR operating units (AEL, AMI, GFL, MTC, REACH, and AMR) were analyzed to identify systemic risks and trends. A dual approach was used: a **decision tree risk model** to pinpoint factors leading to severe clinical outcomes, and **time-series forecasting** (Holt's linear model) to predict high-risk error volumes over the next six months. This comprehensive review revealed that **dosing errors** are the most prevalent and dangerous pattern, contributing ~33% of the severity risk in patient outcomes. Common issues included **exceeding weight-based dose limits** ("limit per kg exceeded") and volume miscalculations, which **outweighed equipment failures** in their impact. Two high-risk medications – **Ketamine** (90 incidents) and **Fentanyl** (66 incidents) – accounted for 28% of all reported errors, underscoring their prominent role in critical events. Additionally, the analysis found **transport modality differences**: the **Air branch** had a higher incidence of **protocol deviation errors** (15.5% of risk contribution), suggesting that the complex in-flight environment hinders checklist adherence and elevates clinical risk.

**Risk Modeling Performance & Key Drivers**

The decision tree **risk classification model** demonstrated **98.4% accuracy** overall and **94.4% recall** for identifying critical/severe outcome cases. This high recall indicates that the model effectively flags most high-severity events, an essential feature given the need to catch every potential harm. The model's results highlighted key **risk-driving factors** behind severe errors. In particular, the presence of **dosing calculation errors**, administering the **wrong medication**, use of certain high-risk drugs (especially Ketamine), and specific service lines or branches (e.g., incidents under the AMR certificate or differences between air vs. ground transport) emerged as strong predictors of critical outcomes. These factors align with the exploratory findings, reinforcing that **dosing mistakes and medication selection** issues, along with **operational context** (branch/certificate), are major drivers of patient harm.

**Forecasting High-Risk Error Volumes**

For forward-looking risk management, **Holt's linear trend forecasting** was applied to medication errors involving high-risk medications (Fentanyl and Ketamine). The six-month projection indicates that **AMR and AEL** will face the highest volumes of serious medication error incidents (approximately **7.9 and 7.1 errors** respectively in the forecast period). Moderate error volumes are expected in **GFL (~6.4)** and **MTC (~4.0)**, whereas **REACH** is

projected to have a low count (~0.9) of such errors in the same timeframe. Forecast confidence varies by service line – for example, AMR's prediction has greater variability (RMSE ~1.40) compared to the more stable AEL forecast (RMSE ~0.59) – indicating higher volatility in AMR's error trends. These forecasts help prioritize attention and resources toward the branches with the greatest anticipated risk.

**Operational Implications & Recommended Actions**

1. Reinforce Medication Cross-Check Protocols for High-Risk Medications (Fentanyl & Ketamine):
   *Implementation:* Mandate the use of a structured medication cross-check verification checklist performed jointly by the flight nurse and flight medic prior to administration of Fentanyl or Ketamine. Prioritize deployment in AMR and AEL, where combined projections show over 15 high-risk errors in the next six months. Incorporate this checklist into pre-mission briefings and in-field practice.
   *Outcome Monitoring:* Track checklist compliance through periodic audits and chart reviews; aim for ≥90% documented use during high-risk medication administrations. Evaluate reduction in Fentanyl- and Ketamine-related errors six months post-implementation, targeting a ≥50% decrease compared to baseline.

2. Launch Targeted Weight-Based Dosing Training Program:
   *Implementation:* Deliver mandatory training focused on pediatric weight-based calculations, particularly for cases involving "Limit per kg exceeded" errors. Roll out initially to AMR and MTC, where weight-based dosing issues have been more frequently observed. Training should include case-based simulations and digital microlearning modules with embedded knowledge checks.
   *Outcome Monitoring:* Require 100% completion from ALS providers in target branches. Conduct a six-month audit of weight-related medication errors before and after training; aim for ≥30% reduction in such incidents post-training.

3. Optimize Air Medical Medication Safety Using Digital Tools and Checklist Reinforcement:
   *Implementation:* Simplify in-flight checklists and integrate mobile app tools like Handtevy for real-time weight-based dosing, along with the medication cross-check checklist used jointly by air crews. Focus on AEL and REACH, where protocol deviation contributed 15.5% of total clinical risk. Include these tools in onboarding, simulation training, and shift briefings.
   *Outcome Monitoring:* Measure app usage rates and checklist adherence via ePCR audit trails and crew self-attestations. Monitor protocol deviation error rates, aiming for ≥25% decline over six months, particularly within Air operations.