Telemedicine in ER Care via 5G AR: Time Series Analysis

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INTRODUCTION

Compared with metropolitan centres, rural communities have fewer healthcare resources, creating substantial barriers to timely care, especially in emergency settings, where minutes matter and preventing avoidable delays can markedly improve outcomes. Our earlier analyses suggested that deploying the 5G-based Remote Healthcare System (5G-RHS) improved several process measures; however, cross-sectional pre/post contrasts can be biased by secular trends and seasonality. To isolate changes attributable to 5G-RHS beyond background variation, we analysed the full continuous time series using an interrupted time series (ITS) design centered on the actual rollout. One hospital contributed a complete pre- and post-intervention series, while other sites provided post-only context. Our objective was to estimate both the immediate level change at implementation and the post-rollout slope change in key ER metrics, and to assess whether 5G-RHS helps rural clinicians deliver care closer to metropolitan standards.

MATERIALS AND METHODS

We analysed multiple clinical measures in trauma cases, including Early Warning rate, FAST (Focused Assessment with Sonography for Trauma) time, transfusion preparation time, total case volume, and mortality rate. We fit an ITS of the form:

$$\text{Outcome} \sim b_0 + b_1\times\text{Post} + b_2\times\text{TimeIndex} + b_3\times(\text{Post}\times\text{TimeIndex}) + \text{Month fixed effects.}$$

We reported coefficients with standard errors, focusing on the level change b_1 (immediate shift at rollout) and the slope change b_3 (difference in monthly trend). We also estimated a pooled fixed-effects model with hospital and month indicators to provide cross-site context.

RESULTS AND DISCUSSION

ITS revealed a significant immediate increase in the Early Warning rate with no subsequent slope change, a step-up that was sustained. FAST time showed a significant immediate decrease without additional post-rollout trend change. Total and severe-case measures exhibited no immediate level shift but a significant downward post-rollout slope, consistent with progressive month-over-month improvement under 5G-RHS. ICU length of stay and severe-case mortality remained same fluctuation pattern. Table 1 summarizes the ITS estimates and standard errors; Figure 1 visualizes the observed series alongside the fitted pre/post segments.

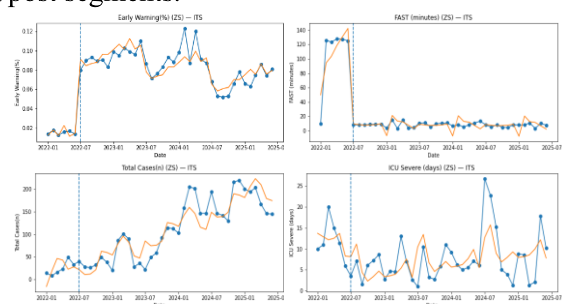

Fig 1 Visualization of observations and fitted ITS.

CONCLUSIONS

ITS indicates that AR-assisted 5G-RHS produced a sharp change in early recognition of patient condition (an immediate level increase in Early Warning percent) and a sustained improvement in time-critical workflows (a month-over-month decrease in transfusion preparation time). For some measures like ICU length of stay and severe-case mortality, implementation of 5G-RHS did not show significant impacts. These gains support AR-enabled tele-mentoring as a scalable approach to narrow rural–urban quality gaps in emergency care.

Table 1: ITS estimates.

	Level_b1_HC3	SE_b1_HC3	p_b1_HC3	Slope_b3_HC3	SE_b3_HC3	p_b3_HC3	R2
Early Warning (%)	0.075	0.009	0.000	0.002	0.002	0.354	0.519
FAST (minutes)	-37.555	67.049	0.575	-16.894	18.984	0.373	0.737
ICU Severe (days)	-7.136	6.680	0.285	0.599	2.101	0.775	0.280
LOS Severe (days)	-5.593	3.657	0.126	-1.246	1.988	0.531	0.439
Mortality of Severe (%)	0.100	0.030	0.001	-0.004	0.005	0.435	0.441
Overall Mortality (%)	-0.007	0.009	0.431	0.002	0.002	0.279	0.442
Preoperative(minutes)	7.824	18.317	0.669	-2.276	5.466	0.677	0.507
Severe Cases(n)	-3.090	4.480	0.490	-0.955	1.042	0.359	0.691
Total Cases(n)	63.385	36.908	0.086	1.375	8.201	0.867	0.337
Transfusion(minutes)	-10.948	15.132	0.469	2.031	3.109	0.514	0.418