



**XLV**

Jornadas de

**Economía de la Salud**

Datos, evidencia, decisiones:  
generando valor para la gestión  
y las políticas sanitarias

Sevilla, 17 al 19 de junio de 2026

# ARIMA modeling for territorial variability and surgical planning



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**Generalitat  
de Catalunya**

**AES**

Asociación de Economía de la Salud





# Case study

## Surgical Indication Adequacy Program for the Girona Health Region

Hospital	Complexity	Procedures
T1	Tertiary	Cataracts
R1	Referral	Varicose veins
C1	Regional	Hip prosthesis
C2	Regional	Knee prosthesis
C3	Regional	Instrumented spine surgery
B1	Basic	Carpal tunnel release
B2	Basic	Hernias





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# Objectives

- Model the behavior of inclusion in waiting lists using the ARIMA methodology for different hospitals and procedures.
- Study and classify the different anomalies of waiting lists.
- Evaluate the models predictive capacity.



# Why ARIMA?

- Inclusion in waiting lists are time series subject to the variability of medical practice in each hospital and procedure.
- Allowing to model:
  - The autoregressive part (AR)
  - The moving-average part (MA)
  - The seasonal part (SARIMA).

Model Formulation

$$\text{SARIMA}(p, d, q) \times (P, D, Q)_m$$



# Modeling results (1)

- In general all models demonstrated high robustness with all  $MASE < 1$  and almost all LB p.values  $> 0.05$
- Three procedure-hospital combinations presented a LB p.value  $< 0.05$  suggesting a possible important structural change in their time series.
- T1 and R1 presented better scaled error metrics indicating that the models fit better in hospitals with higher healthcare burden
- The vast majority of models included the seasonal component. The two procedures that showed the fewest seasonal models were hip replacements and instrumented spine surgeries.

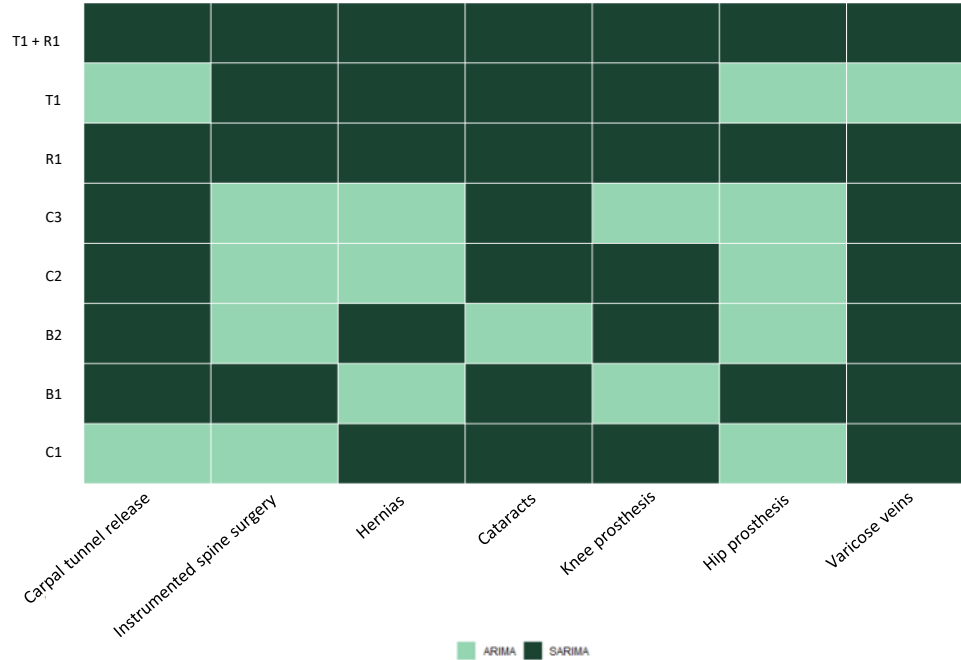


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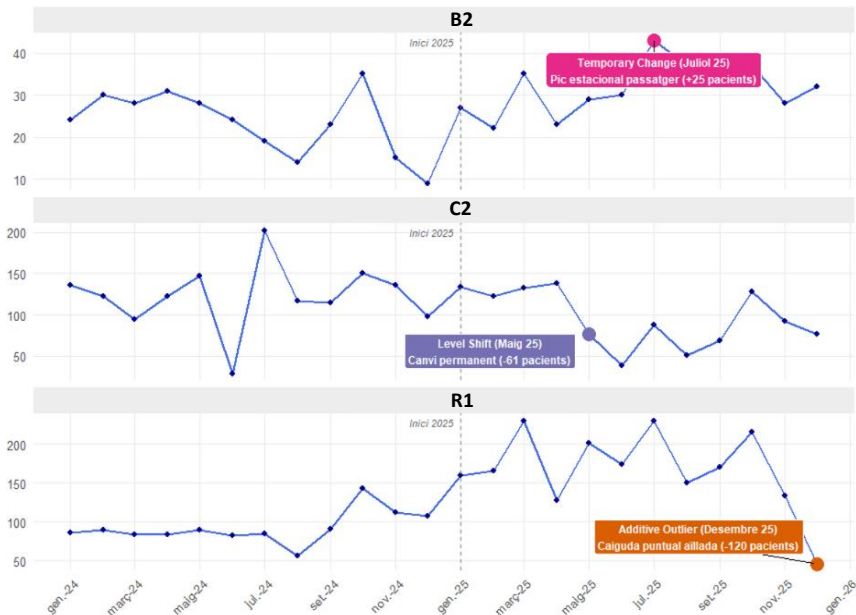
# Modeling results (2)





# Anomaly analysis

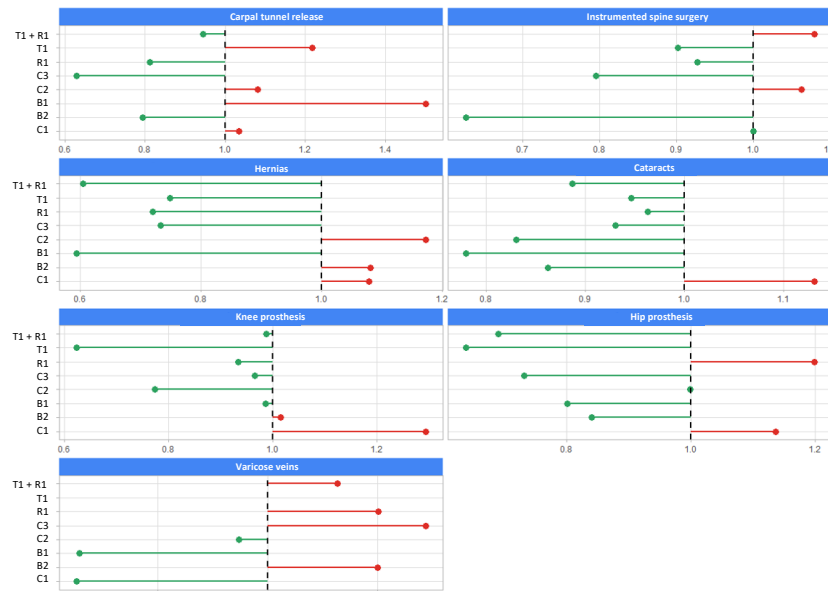
- The analysis was carried out using the Chen and Liu method based in ARIMA methodology.
- Three types of anomaly where studied: Level shifts, temporary changes and additive outliers.
- Ten anomalies were found in 2025. Six were additive outliers, three temporary changes and one level shift.





# Predictive capacity (1)

- To assess predictive capacity, the models were retrained on a training set (2015-2024) and the results were evaluated on a test set (2025).
- The predictions were compared with those of a SNAIVE model.
- The predictive capacity metrics compared were MAE and RMSE.





## Predictive capacity (2)

- The results of the comparisons showed heterogeneity. In general, ARIMA obtained slightly better metrics, especially in bigger hospitals and procedures with greater variability.
- ARIMA models showed fewer large errors than SNAIVE models, but at the general prediction level they only slightly improve the results.

T1 + R1	0.94	1.08	0.61	0.89	0.99	0.69	1.13
T1	1.22	0.9	0.75	0.95	0.62	0.64	
R1	0.81	0.93	0.72	0.96	0.93	1.2	1.2
C3	0.63	0.8	0.73	0.93	0.97	0.73	1.29
C2	1.08	1.06	1.17	0.83	0.77	1	0.95
B2	1.5		0.59	0.78	0.99	0.8	0.66
B1	0.79	0.63	1.08	0.86	1.02	0.84	1.2
C1	1.04	1	1.08	1.13	1.29	1.14	0.65
	Carpal tunnel release	Instrumented spine surgery	Hernias	Cataracts	Knee prosthesis	Hip prosthesis	Varicose veins



# Conclusions

- ARIMA models are a useful tool when studying the distribution and variability of waiting lists.
- In general, waiting lists for the procedures studied show a seasonal distribution.
- During the study period, an anomaly was found that could be attributed to the surgical inclusion program.
- In most cases, the predictive capacity of ARIMA models is slightly better than that of SNAIVE models.
- As future work, it is proposed to carry out this analysis for all hospitals in Catalonia to identify which patterns are followed by hospitals and surgical procedures where ARIMA performs best.



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