european cancer SUMMIT 2026

Computational reconstruction of prediagnostic care pathways identifies missed opportunities for earlier glioblastoma diagnosis in Europe

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Introduction

Glioblastoma is the most aggressive primary malignant brain tumour in adults, with **median survival of 15–18 months**.

Unlike breast, colorectal or cervical cancer, **no validated screening strategy exists**: timely diagnosis depends on recognising evolving neurological symptoms in routine care.

Existing studies describe presenting symptoms but rarely quantify **where, and how much, health systems contribute** to late diagnosis.

Aim

Reconstruct prediagnostic care pathways to quantify preventable delay and inform standardised red-flag referral criteria for earlier detection.

Methods

Linked records CPRD + HES + NCRAS (de-identified, UK) › **12-month lookback** GP, emergency, referral & imaging events › **Temporal graphs** Directed graphs of each diagnostic trajectory › **Regression** Patient- & system-level predictors of delay

- **Design:** longitudinal cohort of adults diagnosed with glioblastoma, [STUDY YEARS].
- **Pathway reconstruction:** primary care encounters, emergency visits, referrals and neuroimaging timelines in the 12 months before diagnosis.
- **Red-flag mapping:** guideline-defined red flags mapped against expected referral and imaging pathways.
- **Analysis:** multivariable regression of patient- and system-level predictors of delay.

New-onset seizure · Progressive focal deficit · Persistent headache + cognitive decline · Personality change · Gait disturbance

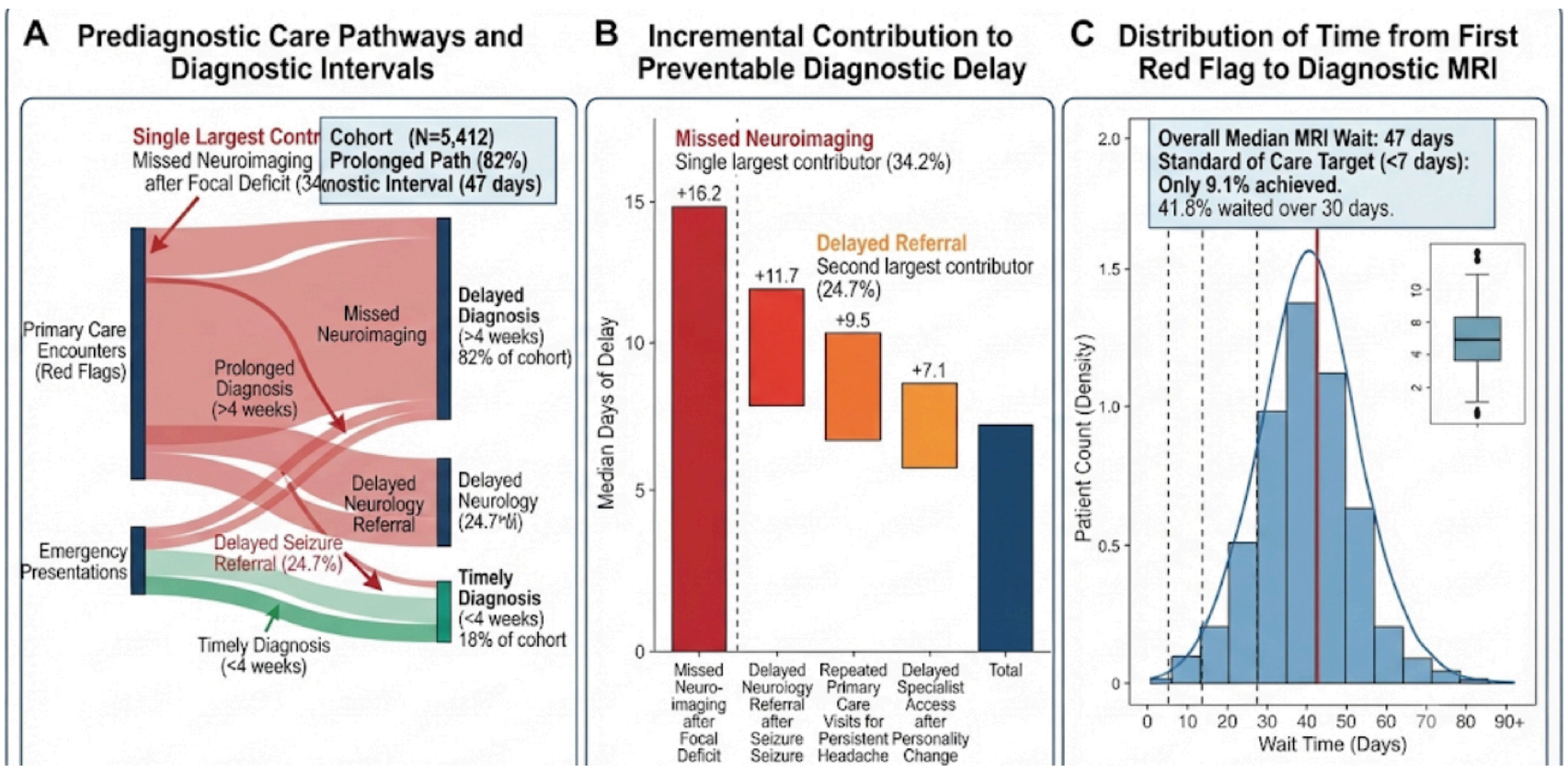

Figure 1

Reconstructed prediagnostic care pathways and systemic delay factors in glioblastoma (N = 5,412): **(A)** patient journey distributions; **(B)** incremental contribution of specific system bottlenecks to preventable delay; **(C)** distribution of wait times from first red flag to diagnostic MRI.

Results

5,412 adults diagnosed with glioblastoma

68.4% had a documented red-flag encounter before diagnosis

47 days median time from first red flag to diagnostic MRI

41.8% waited more than 30 days for MRI

34.2% of preventable delay: missed neuroimaging after progressive focal deficit

24.7% of preventable delay: late neurology referral after new-onset seizure

- **Five recurrent trajectories** accounted for **82%** of all prolonged diagnostic intervals: systemic patterns, not isolated cases.
- Patients managed **only in primary care** waited significantly longer than those with direct emergency neurology assessment [ADD EFFECT SIZE, 95% CI, p].

Conclusions

Delay is systemic

Most patients present with red flags, yet recurrent pathway failures, not chance, drive prolonged diagnosis.

Fix the referral pathway

Standardised red-flag protocols, direct access to neuroimaging and rapid specialist assessment target the largest sources of preventable delay.

Next step

Prospective validation to test scalability across European health systems, alongside improved health literacy and coordinated diagnostic pathways.

References

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