Building on Routinely Collected Health Data for Precision Population Care in Inflammatory Bowel Disease

Gemma Postill and Eric I. Benchimol

Abstract

The growing burden of multimorbidity among individuals with inflammatory bowel disease (IBD) presents a critical challenge for health systems, as it signals the need to shift from single-disease-focused care to integrated multimorbidity-focused care. Recent Canadian population-based research has demonstrated that multimorbidity in IBD follows distinct patterns and that these patterns can be leveraged using machine learning (ML) to predict premature mortality. This column draws on two recent studies evaluating populations with IBD – one identifying multimorbidity clustering among individuals with IBD and another applying ML to predict premature death from non-IBD chronic conditions – to explore how these findings can inform health system planning, clinical care and policy decision-making.

Introduction

Health systems across Canada are increasingly confronted with rising chronic disease burden and growing patient complexity (Rosella et al. 2018). Multimorbidity is the co-occurrence of two or more chronic conditions. Inflammatory bowel disease (IBD) provides an important example of the challenges posed by multimorbidity in chronic disease management (Argollo et al. 2019; Postill et al. 2025a, 2025b). Canada has one of the highest prevalence rates of IBD globally, and the burden of disease continues to grow due to both an aging population and rising incidence among children and young adults (Coward et al. 2023). As individuals with IBD live longer and accumulate additional chronic conditions, understanding how multimorbidity develops and influences outcomes becomes increasingly important for health system planning, resource allocation and models of care.

Recent population-based research, enabled by decades of investment in linked health administrative data, provides new insight into how multimorbidity develops and influences outcomes in IBD. Specifically, the findings of two recent studies – one characterizing multimorbidity with machine learning (ML) clustering approaches and another applying ML to predict premature mortality – provide guidance into how we can move beyond the single-disease paradigm commonly applied to research and care to a more integrated, data-driven approach that recognizes the complexity of multimorbidity. In this column, we reflect on the implications of these studies for health system planning, clinical care and policy decision-making.

Advancing Conceptualization of Multimorbidity for Precision Population Care

Despite widespread recognition of its importance, multimorbidity remains variably defined and measured across studies (Chowdhury et al. 2025). While the overarching concept of multiple chronic conditions is consistent across studies, substantial heterogeneity exists with respect to which conditions are included and how they are operationalized (Chowdhury et al. 2025). To address this challenge, a recent Delphi study incorporating both professional and public perspectives established guidance on a multimorbidity measurement, recommending a core set of conditions to include in analyses and distinguishing between approaches suited for different purposes (Ho et al. 2022). Simple condition counts were preferred for estimating prevalence and examining clustering or trajectories, whereas weighted measures were recommended for risk adjustment and outcome prediction (Ho et al. 2022).

However, there is growing recognition that conceptualizing multimorbidity as a singular construct is insufficient. From both clinical and population health perspectives, it is not merely the presence of multiple conditions that matters, but the specific combinations, interactions and trajectories of those conditions (Slade et al. 2026). This reframes multimorbidity as a dynamic construct that requires access to integrated, longitudinal population data capable of capturing disease onset, progression and outcomes over time. Such approaches can enable more nuanced analyses that inform precision population health strategies.

Multimorbidity Patterns Confer Distinct Premature Mortality Risk

A recent study published in *CMAJ* demonstrated that non-IBD chronic conditions could predict premature mortality among individuals with IBD (Postill et al. 2025a). A key contribution of this work was the incorporation of multimorbidity as a structured input reflecting patterns of chronic disease co-occurrence, not simply as a count of conditions. Features used as predictors included the age of onset of 18 individual chronic conditions and sex. By capturing interactions and non-linear relationships between conditions, the models were able to achieve improved predictive performance compared with traditional approaches.

Model interpretability techniques highlighted the specific conditions and the age of onset of each that were the strongest predictors of premature mortality (mood disorder, osteoarthritis and other forms of arthritis, mental health disorders and hypertension as well as male sex). The co-occurrence of these conditions with IBD can be related to the pathophysiology and/or the psychosocial implications of living with IBD. Indeed, elsewhere in the literature, individual conditions have been associated with increased risk of mortality (Walker et al. 2015; Wang et al. 2020). However, taken together, these findings implicate that premature mortality risk in populations with IBD may be conferred by distinct patterns of multimorbidity.

For health systems, the use of *premature* mortality as the outcome more directly identifies opportunities for health system improvements, as premature deaths are considered avoidable through appropriate prevention or early and effective treatment (Statistics Canada 2023). The identified strong relationship between patterns of multimorbidity onset and premature mortality emphasizes the need to consider the timing and patterning of specific conditions, in addition to multimorbidity itself, for the identification of high-risk subpopulations in precision population health approaches.

Multimorbidity Patterns Among Individuals With IBD

In a separate study published in *Communications Medicine*, clustering with unsupervised ML was used to identify distinct clusters of chronic conditions among individuals with IBD, suggesting that multimorbidity is structured and patterned in populations with IBD (Postill et al. 2025b). Rather than treating each condition independently or simply counting the number of comorbidities, the data inputted into the clustering algorithm included the temporality of conditions among individuals (Postill et al. 2025b). Clusters were associated with differences in health outcomes, with the proportions of premature deaths ranging from 26 to 76%, suggesting that the type and combination of conditions identified by the unsupervised ML approach are clinically meaningful (Postill et al. 2025b).

The specific multimorbidity phenotypes identified included: (α-cluster) IBD with hypertension, mood disorder, other mental health disorders, and osteoarthritis and other forms of arthritis; (β-cluster) IBD with high prevalence of cancer and low multimorbidity; and (γ-cluster) IBD with mood disorders and cardiovascular comorbidities (Postill et al. 2025b). While it is possible that some clusters reflect IBD severity, others may not be unique to IBD. For example, a cardiovascular cluster (like the study's γ-cluster) has also been observed among other clinical populations, including those with serious mental illness (Ma et al. 2023) and in-hospital community-acquired pneumonia (Malecki et al. 2023).

Importantly, clustering analyses are fundamentally hypothesis-generating. They identify patterns of association within data rather than causal mechanisms and cannot determine whether the identified groupings directly influence outcomes. While these findings suggest that certain combinations of conditions are associated with different health outcomes, further work is required to understand the biological, behavioural and healthcare-system factors underlying these patterns. Although the clinical significance of individual multimorbidity phenotypes may not yet be fully understood, identifying recurring patterns remains valuable from an epidemiological and health system perspective. Such patterns can support population segmentation, identify groups with differing healthcare needs and outcomes and inform the design of targeted prevention, surveillance and care strategies.

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Longitudinal, Population-Level Health Data Enables Capturing of Disease Trajectories

A defining strength of both studies is their use of longitudinal health administrative data. In Ontario, repositories of such data (housed at ICES) enable researchers to follow individuals over extended periods. This long look-back window allows for the reconstruction of the timing, sequence and accumulation of chronic conditions. Specifically, the temporal dimension and scale afforded by these longitudinal, population-level data are critical for being able to apply advanced analytic approaches, including ML, to uncover clinically meaningful patterns. However, condition onset as captured in these data reflects when care was sought and algorithmic condition diagnosis was met (e.g., two or more visits to a primary care provider for a specific reason).

Operationalizing such dynamic definitions of multimorbidity requires substantive foundational research to develop validated methods for the identification of chronic conditions

in health administrative data. Thus, the highlighted work builds on decades of foundational research in algorithm validation (Benchimol et al. 2011). Without this prior work establishing reliable, reproducible algorithms for disease identification, it would not be possible to conduct the aforementioned large-scale, population-based studies of multimorbidity. In this way, current advances in ML are directly enabled by long-standing investments in data quality, validation and infrastructure.

From Insight to Implementation

The combined insights from these studies can guide how care is organized and delivered. Care models must evolve to reflect the realities of multimorbidity, with greater emphasis on interdisciplinary and patient-centred approaches. The described analytic approaches provide a mechanism for identifying high-risk individuals with IBD who may benefit from intensified monitoring, multidisciplinary care or early intervention. While integrated, team-based approaches may more effectively manage these patients, we recognize that structural barriers to the implementation of multidisciplinary care in practice exist (Mathias et al. 2023). Multimorbidity-informed risk stratification provides a data-driven foundation for identifying priority populations and opportunities to improve care delivery. Furthermore, analogous dynamic population segmentation and predictive approaches, when embedded into care pathways, can support real-time clinical decision-making and enhance coordination. To enable such approaches, there must be sustained and expanded investments in data infrastructure.

Conclusion

The integration of ML with population-based health data offers a powerful approach to understanding and addressing multimorbidity in IBD. The studies highlighted in this column demonstrate that multimorbidity is structured and that recurring patterns of chronic disease co-occurrence are associated with important health outcomes. While these patterns should be interpreted as hypothesis-generating rather than causal, they provide valuable insight into population heterogeneity and opportunities for more targeted approaches to care. Crucially, these advances are built on decades of investment in health data infrastructure and validation science. For Canadian health systems facing increasing complexity and demand, leveraging these insights and analytic approaches represents a significant opportunity to support discovery of more proactive, coordinated and data-informed care approaches. Realizing this potential will require continued investment, thoughtful governance and a commitment to translating evidence into practice. HQ

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About the Authors

Gemma Postill is an ICES student at ICES Central and an MD/PhD candidate at the Institute for Health Policy Management and Evaluation, Dalla Lana School of Public Health, University of Toronto, Toronto, ON. Gemma Postill can be reached by e-mail at gemma.postill@utoronto.ca.

Eric I. Benchimol is a senior core scientist at ICES Central and a professor in the Department of Paediatrics and the Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto, ON.