Predicting Clinical Remission in Crohn's Disease: A Comparative Study of Expert-Generated and Computer-Generated Bayesian Networks

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Keywords

1. Background

In Crohn's disease (CD), artificial intelligence (AI) may improve treatment optimization and aid in clinical decision-making[1]. The aim of the study is to compare the results of Bayesian Networks (BNs) of both Expert Knowledge Model (EKM) and Computer Algorithm Generated Model (CAGM) in predicting corticosteroid-free clinical remission at 52 weeks after introducing ustekinumab and vedolizumab treatment in patients with CD.

2. Methods

Data were extracted from the Dutch Initiative on Crohn and Colitis (ICC) registry. Observations were conducted on patients with CD (n = 440) based on remission criteria including Harvey Bradshaw Index (HBI<5) assessment and no corticosteroid use. Data were divided into training (70%, N = 309) and validation (30%, N = 131) subsets. Based on these, two Bayesian network models were developed. Expert knowledge gathered through three consultation rounds with 12 specialists was used to generate an EKM using a Directed Acyclic Graph and K2-scoring method to refine and accurately represent node relationships in the model. Furthermore, the Hill Climbing search algorithm was applied to build CAGM[2]. Finally, node elimination was applied to reduce complexity and further optimize the performance of both EKM and CAGM.

3. Results

The EKM contained 21 expert-defined variables and 38 edges between them. There were ten direct parent nodes in the EKM final round of node elimination, including age at diagnosis, disease duration, gender, smoking status, calprotectin, C-reactive protein (CRP), thrombocytes, prior surgery, previous medication, and perianal disease. The EKM showed AUC, accuracy, sensitivity, and specificity values of 0.70, 0.64, 0.15, and 0.92, respectively. On the other hand, the CAGM contained 14 variables and 17 edges. Six direct parents were left in the final round, including previous medication, prior surgery, CRP, perianal disease, thrombocytes, and age at diagnosis. The CAGM showed an AUC, accuracy, sensitivity, and specificity values of 0.59, 0.62, 0.17, and 0.88, respectively. Consequently, age at diagnosis, previous medication, thrombocytes, and perianal diseases were common nodes left in both models.

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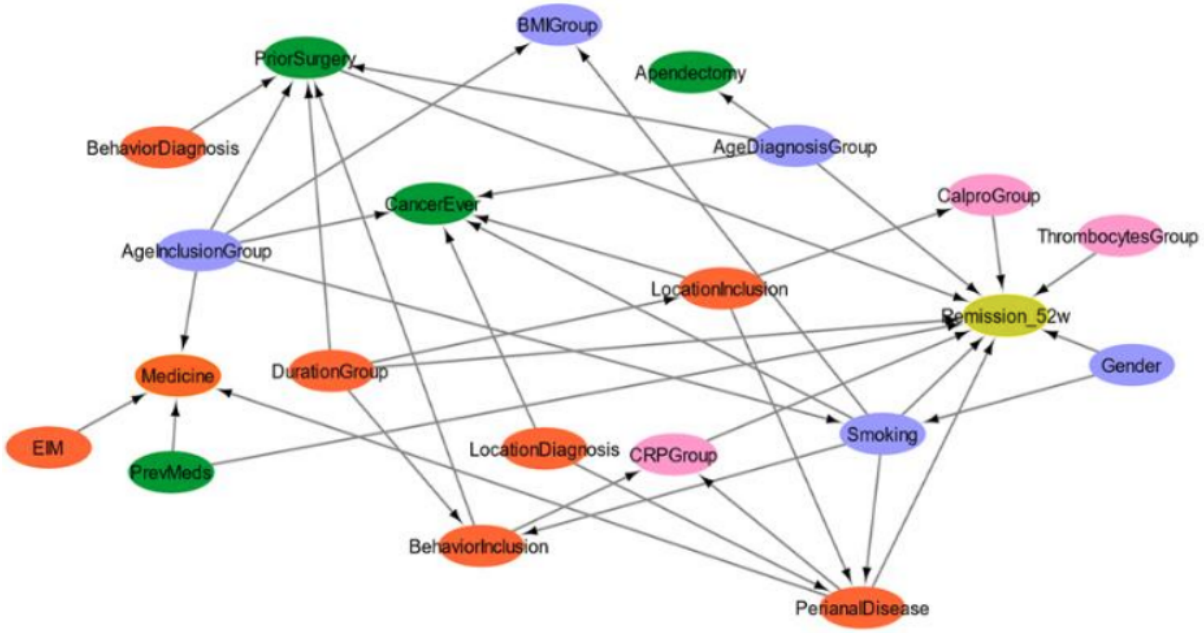
Figure 1: Expert generated network. Nodes are color-coded based on categories: orange a disease specific classifcation and current treatment, lavender a demographs, green a medical history, pink a laboratory test, mustard a Patient Reported Outcome Measures (PROM). After 8 node elemination rounds, the expert network was reduced to 13 nodes and 17 edges



4. Conclusion

In this comparative study, after rounds of node elimination, the expert-generated model has a higher AUC than that of the computer-generated model. The findings indicate that expert knowledge models provide a deeper, more comprehensive influence on Crohn's remission outcomes compared to computer-generated models. With BNs capacity to incorporate expert information and surpass algorithm-only methods in remission prediction, they may provide physicians with a potent, interpretable tool for individualized decision-making and enhancing diagnostic precision.

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Declaration on Generative AI

The authors have not employed any Generative AI tools.

References

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Figure 2: Computer generated network using HC (K2 scoring)-generated network. After node elimination rounds, the HC generated network was reduced to 11 nodes and 14 edges.