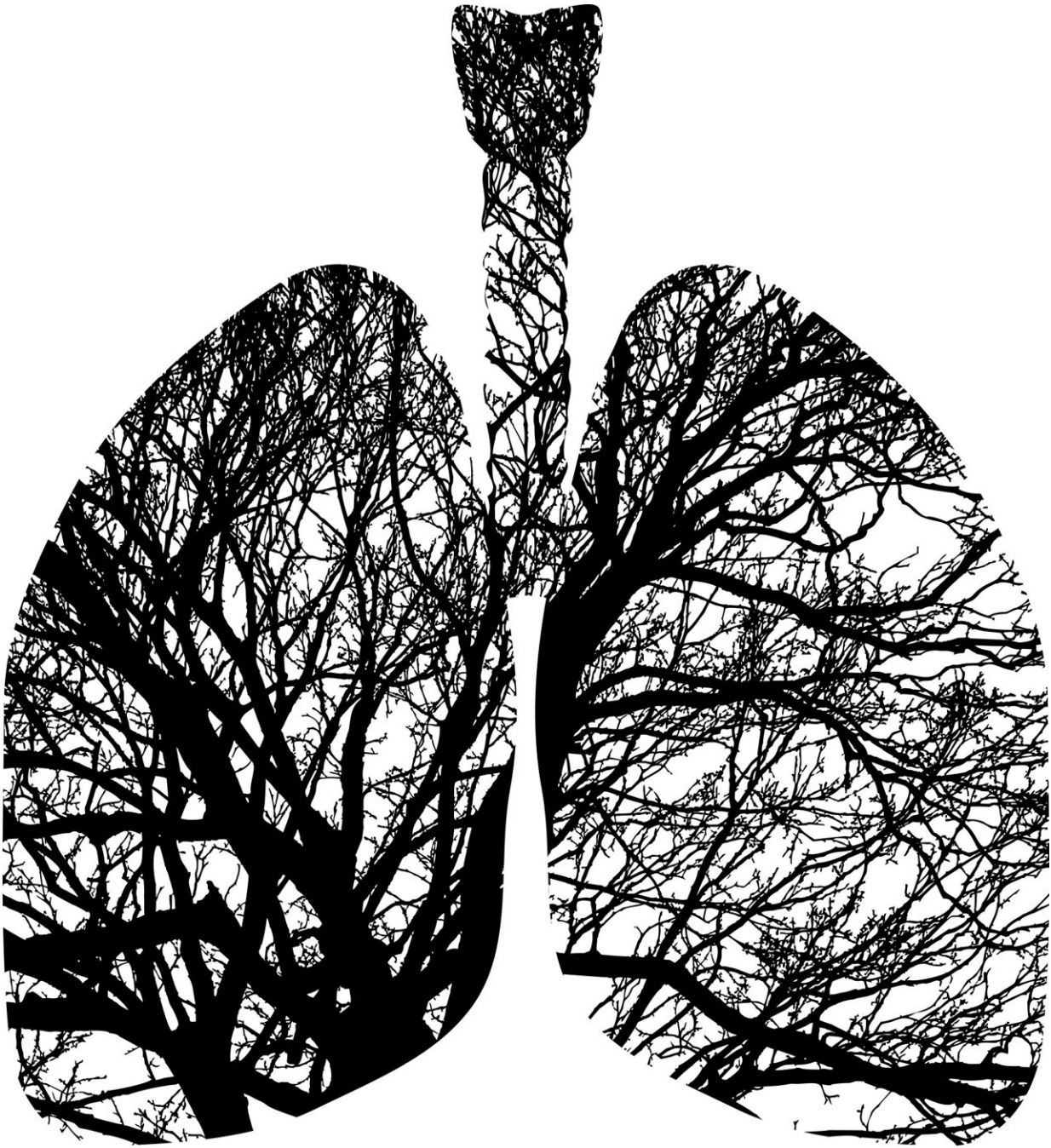# Lung cancer: Predicting which patients are at high risk of recurrence to improve outcomes

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Lung cancer is responsible for more deaths than breast, colon and prostate cancer combined.

With advancements in [lung cancer](#) screening, it is expected that more patients will be diagnosed at earlier stages, enabling them to undergo surgery, the primary treatment modality for early-stage patients.

However, a significant proportion of patients will have a recurrence of their cancer after resection (surgery to remove the tumor). Unfortunately, current clinical guidelines cannot help predict which patients are at risk. Better knowledge of who is at risk has significant implications for systemic therapy selection such as chemotherapy for early-stage lung cancer patients after surgery.

To find solutions to this problem, our research group at McGill University launched a project in collaboration with Université Laval. [Preliminary](#) results were published in *Nature*. In our work we discovered that the use of a new imaging technology, along with artificial intelligence, could improve outcomes for cancer patients.

Too much or too little intervention

This clinical dilemma has important implications for the choice of treatment, such as chemotherapy. For example, lung cancer patients who are cured by surgery could be spared the toxicity of chemotherapy. Patients at risk of their cancer recurring could benefit from additional therapeutic interventions.

The challenge of predicting recurrence for patients with early-stage lung cancer has important implications for the 31,000 Canadians who are diagnosed with this terrible disease every year.

Mass cytometry imaging

To address this clinical problem, we used [imaging mass cytometry](#)

(IMC), a new technology that allows for a comprehensive characterization of the tumor microenvironment.

The tumor microenvironment is a complex ecosystem composed of interactions between tumor cells, immune cells, and various structural cells. IMC can be used to visualize up to 50 markers at the cell surface, significantly more than was previously possible.

This technology makes it possible to identify different types of cells and determine their spatial organization, i.e. how they interact. IMC produces images that can be analyzed to determine the frequency of cell subpopulations, their activation states, the other cell types with which they interact and their organization in cellular communities.

The results of our study, published in *Nature*, reveal that various cell types can interact in cellular communities, and that communities composed of B cells were strongly associated with prolonged survival in lung cancer patients. Our study highlights that beyond cellular frequency, cellular interactions and spatial organization also correlate strongly with important clinical outcomes such as survival.

Using artificial intelligence to make better predictions

Based on our initial results, we hypothesized that important spatial features embedded within IMC images, such as cellular interactions, could be important in predicting clinical outcomes.

Our dataset of 416 patients and over 1.6 million cells provided sufficient power to make predictions using artificial intelligence. We sought to predict which patients with early-stage lung cancer would have a recurrence of their cancer after surgery.

Using 1 mm2 tumor samples, material readily available from surgical

resections or biopsies, we used artificial intelligence algorithms together with IMC images to make our predictions. Our algorithm was able to predict with 95 percent accuracy which patients would experience a cancer recurrence by using the spatial information contained within the images.

Six markers can make all the difference

One of the challenges in applying our results in a clinical setting is that IMC is not readily available. Clinical pathologists typically use less complex technologies such as immunofluorescence, which are often limited to three or fewer markers.

To address this challenge, we sought to identify the minimum number of markers needed to make meaningful predictions about recurrence in lung cancer patients after surgery. By using six markers, we obtained an accuracy rate of 93 percent, a result that is close to the 95 percent accuracy rate obtained by using 35 markers.

These results suggest that by harnessing the power of artificial intelligence with existing technologies available in hospitals, we may be able to improve the post-surgical clinical management of patients with early-stage lung cancer. Our ultimate goal is to increase cure rates for those at high risk of cancer recurrence, while minimizing toxicity for those who can be cured by surgery.

More information: Mark Sorin et al, Single-cell spatial landscapes of the lung tumour immune microenvironment, *Nature* (2023). DOI: 10.1038/s41586-022-05672-3