Zimin Institute for Engineering Solutions Advancing Better Lives

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Identification of intraperitoneal free cancer cells during surgical procedures for disease management: a multidisciplinary engineering solution using deep learning and real-time-rapid sequencing technology

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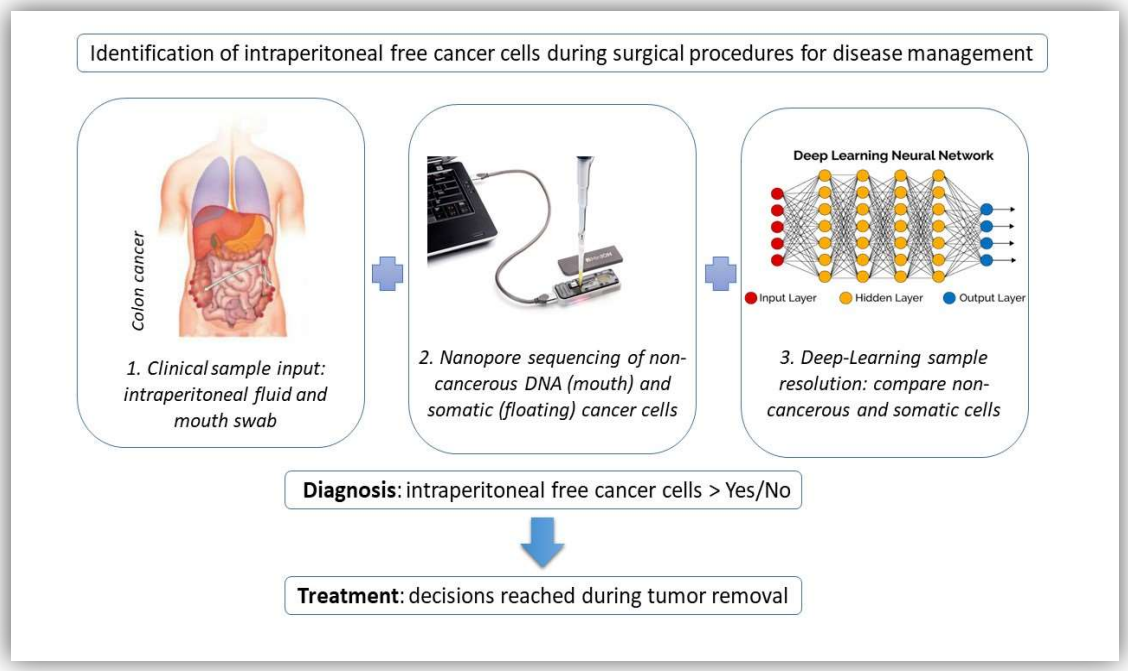

We fit the Zimin Institute ideas

We propose a solution for a pertinent medical question

We employ deep learning algorithms in our solution

We use a multi-disciplinary approach in our research

Background

Intra-abdominal malignancies often result in intraperitoneal free cancer cells (IPCCs), which increase the chances of cancer spreading to distal organs, and serve as an important prognostic tool in cancers such as ovarian and gastric cancers. Curative treatments based on intraperitoneal chemotherapy often have effective outcomes, however, the time between IPCC sampling and detection is critical, currently taking weeks to reach a conclusion. The MinION (Oxford Nanopore Technologies) – the first handheld genetic sequencer – is capable of reading long stretches of DNA in a real-time, but has not yet reached the level of accuracy of older, slower technologies. Deep learning techniques mimic the learning process of the human brain in order to recognize patterns in digital representations. In our lab, we use deep learning to circumvent the limitations of Nanopore sequencing by learning the 'signal' rather the 'sequence' of the DNA. The aim of our project is to establish a rapid real-time method for the detection of IPCCs during colorectal resection. We propose a solution that takes advantage of our close collaboration with the Surgery Division at Sourasky Medical Center, and is based on three components: (i) access to clinical samples (abdominal fluid and mouth swabs) collected during resection; (ii) rapid real-time DNA sequencing; and, (iii) deep learning algorithms for the discrimination between somatic versus non-cancerous DNA. We believe the time has come to merge DNA sequencing (as a 'digital signature') with deep learning in order to afford surgeons the opportunity to quickly identify IPCCs during surgical procedures, thereby allowing immediate treatment and decreasing the need for future intervention.

Major findings

We have demonstrated the capability of our deep learning platform to detect cancer from "traditional" sequencing technologies with better accuracy than any other algorithms. Here we ran the nanopore sequencing and showed that it can serve as a better sequencing platform for cancer detection and diagnosis. We performed sequencing of clinical samples derived from cancer patients, analyzed the results in context of cancer diagnosis and have demonstrated findings both in terms of mutation analysis (Genetics) and DNA modification analysis (Epigenetic). We conclude that nanopore sequencing at its current state has large potential for the purpose of cancer detection and diagnosis. We were the first to combine our deep learning platform with nanopore sequencing in order to utilize the advantages of both technologies. Our work will propel cancer research forward by vastly improving the accuracy, turnaround time, and accessibility of cancer detection.