

Focus Area: Epidemiology

Introduction

Epidemiology is the study of causes of health outcomes and diseases within populations.¹ While the ongoing COVID-19 pandemic has garnered great interest in the field, epidemiology is a lot more than just the study of infectious diseases.² Research in epidemiology contributes significantly to curbing non-communicable diseases (NCDs) like cardiovascular disease, diabetes and chronic respiratory disease.³ Psychiatric epidemiology is also an important and interesting sub-field.



Background

The focus area is evidently broad, and there is a lot of scope to do interesting research in whatever part of epidemiology you choose to study. Data centric approaches may be fruitful in detecting potential causes of a disease, certain at risk populations, or potential outbreaks of both infectious diseases and NCDs. Such methods may also be useful in evaluating the effectiveness of public health programs. For example, using public health data – like that provided by the City of Toronto⁴ – to study vaccination and infection patterns may lead to some interesting results about vaccine efficacy.



Epidemiological study can also lead to more effective public policy decisions.⁵ From mask policy for the COVID-19 pandemic, to the ban of cigarette smoking in New Zealand,⁶ many political decisions are often informed by the study of causes and cures for certain diseases. Evaluating what policies are effective and what makes a policy effective for a particular region or demographic may lead to compelling discoveries. Comparative studies between regions or demographics could provide significant insight into what makes one group less or more susceptible to a disease than another. Such studies are useful also in finding ways to mitigate potential outbreaks by studying trends of similarity between two groups and inform on what parameters need focus. This technique was useful in finding potential causes for the increase of cardiovascular diseases in India, and proposing certain ways to reverse this increase by comparing risk factor trends with the USA.⁷

Transfer learning may be useful for making models usable in multiple scenarios. This may be particularly useful for cases where data is sparse in one area of interest but abundant elsewhere. Such an approach has been used to improve mortality prediction in data-scarce hospital settings.⁸ A more challenging avenue could entail transferring to domains with sparse, faulty or unlabeled data, or to new disease research where a similar type of disease has already been well documented. This kind of method proved effective for self-harm risk classification of social media posts where little labeled data was available.⁹

¹<https://www.cdc.gov/careerpaths/k12teacherroadmap/epidemiology.html>

²<https://trends.google.com/trends/explore?date=all&q=%2Fm%2F0hmf>

³<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5870425/>

⁴<https://www.toronto.ca/home/covid-19/covid-19-latest-city-of-toronto-news/covid-19-status-of-cases-in-toronto/>

⁵<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4794978/>

⁶<https://www.theguardian.com/world/2021/apr/16/new-zealand-aims-to-create-smoke-free-generation-cigarettes>

⁷<https://www.sciencedirect.com/science/article/pii/S073510971834664>

⁸<https://journals.sagepub.com/doi/10.1177/1178222617712994>

⁹<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7254287/>

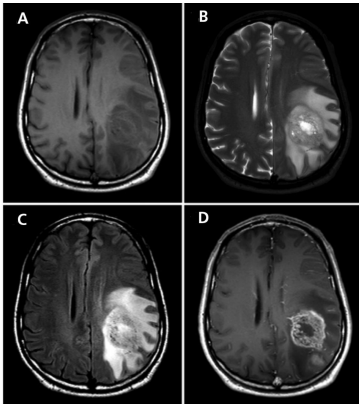
Focus Area: Clinical Practice

Introduction

Clinical practice encompasses the adopted methods and regulations for the delivery of healthcare by doctors, nurses, and other professionals.¹⁰ From the introduction of the first vaccines to immunotherapy¹¹ and telemedicine delivery, this is an area where research is constantly applied towards developing better procedures for disease prevention, effective prognosis, diagnosis, and treatment. While epidemiology pertains to public health, advancements in clinical practices are more focused on improving personal healthcare experiences such as credible decision support systems for assisting clinicians during diagnosis, or alert systems that can notify clinicians of deteriorating patient states.¹²



Background



Global healthcare systems constantly face several challenges with widespread illnesses, rising medical costs, staffing shortages along with poor experience of care. In light of the present pandemic, we are in dire need of more robust and advanced clinical systems that could help us get through such resource constrained times.

Advancements in the field of medicine has always been in line with technological developments. The availability of large volumes of EHR data has given way to leveraging machine learning algorithms for developing a diverse range of applications. Semi-supervised learning was used for extracting diagnosis and investigation results from unstructured free text data.¹³ In the case of ovarian cancer where the initial symptoms of the disease are very subtle, gaining insight from early free text diagnosis would be essential for the patient's treatment. Better prognosis can also be made with the help of capsule networks that have been successful at detecting cancerous brain tumor by classifying medical imaging data.¹⁴

Sepsis treatment is considered to be very challenging for the medical world, however reinforcement learning techniques such as tabular Q-learning and deep Q-learning have helped find the most plausible treatment policies.¹⁵

Another interesting modern healthcare application is Doctor AI, that makes use of recurrent neural networks and EHR encounter records such as diagnosis and medication codes to predict the diagnosis and medication category for a patient's subsequent visit.¹⁶ Although this area of research is broad in nature, the outcomes of your research evidently will have a significant impact on everyday health care practices as well as our ability to withstand global health crises.

¹⁰<https://medical-dictionary.thefreedictionary.com/clinical+practice>

¹¹<https://www.cancerresearch.org/immunotherapy/what-is-immunotherapy>

¹²<https://ccforum.biomedcentral.com/articles/10.1186/s13054-020-02962-y>

¹³<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0030412>

¹⁴https://ieeexplore.ieee.org/abstract/document/8451379?casa_token=BtgGu_9jIIUAAAAA:mZj34cqfQIvRxy7nTZL3oIEnji26q_MY45XXkgQFTrYyffyGb05z4ZvkvmurpapfhFnSUJ6VxA

¹⁵<https://openreview.net/pdf?id=BJekwh0ToN>

¹⁶<http://proceedings.mlr.press/v56/Choi16.pdf>

