Paediatric big data and analytics to improve the management of infectious diseases in children

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In 2020 the global under-five mortality rate was 37 deaths per 1000 live births, with pneumonia, diarrhoea, malaria, measles and meningitis, the leading causes of preventable or treatable deaths in this age group.[1] In the absence of data on the incidence and prevalence of these diseases (morbidity data), mortality data reflect the social, economic, and environmental conditions in which children live, including their health care.

As a multidimensional system that encompasses prevention, diagnosis, and treatment of health-related impairments, health care involves the daily collection of large sets of heterogenous data sources—so called big data—for different purposes including clinical care, administration, and research.[2] Within the sphere of routine health care big data is synonymous with structured, semi-structured, or unstructured information from clinical decision support systems (physicians' written notes and prescriptions, medical imaging, and laboratory, pharmacy, insurance, and other administrative data); patient data in electronic medical records (from central public authorities, primary and secondary care, and large hospitals); clinical trials and other research studies; omics and sequencing-based outputs and their associated banked samples; and machine-generated/sensor data such as from monitoring vital signs, mobile phones, and wearable devices.[3] By discovering associations and understanding patterns and trends within health care data and translating these into interpretable and potentially actionable sets of information, big data analytics can be leveraged for predictive modelling to guide evidence-based clinical decision making, improve care, save lives, and reduce costs.[4] The inclusion of geographical and environmental information may further increase the ability to interpret gathered data and extract new knowledge. This would be an advantage for patient care in many low-income and middle-income countries where access to high-quality care may often be limited due to shortage of clinical expertise and diagnostic facilities.

Timely and accurate diagnosis of infectious diseases in children facilitates appropriate treatment and has the potential to reduce mortality. For example, big data and analytics including machine learning and artificial intelligence can be used to support multi-faceted diagnosis of childhood pneumonia in resource-constrained settings, compensating for the shortage of expensive equipment and highly trained clinicians.[5] Each year, large numbers of paediatric bacterial culture results are generated, with increasing amounts of genome sequencing data now being generated for many of those cultures. The application of big data analytics to integrate routine clinical and laboratory data with omics and sequencing-based outputs and their associated banked samples may help translate personalised medicine initiatives into clinical practice. Predictive modelling can enable clinicians to distinguish children who will benefit from a specific therapeutic intervention from those who will not.[4] Clinical decision-support tools can mine these data to enable precision diagnosis for conditions such as paediatric sepsis and pneumonia, as well as recommend specific treatments tailored to the individual needs of each child.

Ubiquitous data sources such as the internet and mobile cell phone use provide accessible data about social behaviour including child absence from school due to illness, the types and sources of medicines bought by parents or caregivers, and information communicated to schools and social networks. The combination of traditional facility-based clinical data with non-traditional data sources can improve our understanding of informal referral systems and identify early intervention points in the pathways to care between the community and hospital, as well as follow-up care after discharge from hospital.[6,7] The use of mobile devices in health (mobile health or mHealth) coupled with related big-data analytic technologies also creates novel delivery models that can be integrated with existing health services to enhance communication between patients and health care professionals and improve health outcomes and service delivery.[8] mHealth interventions have been shown to be effective in eliciting meaningful improvements in paediatric health behaviour and associated health outcomes, particularly for chronic illnesses; however, interventions with caregiver involvement produce larger changes in health outcomes, on average, than those that exclusively target children.[9] Immunisation is the most cost-effective public health intervention for the control of infectious diseases, particularly among infants and young children; providing mobile phone

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reminders to caregivers has been shown to improve childhood immunization coverage.[10] Mobile phone-based tools have shown promise in the identification of symptoms of common childhood diseases and may be used to support families of children living in rural and remote areas with limited access to healthcare.

Despite the numerous opportunities big data and analytics offered, the main barriers to implementing big data in the management of paediatric infection are the interoperability and integration of technologies used. The differences in data structure and lack of data and protocol standardization makes integration of the various databases difficult. Secure platforms with better communication standards and protocols for data storage, transfers and governance are vital to ensure data security and privacy. As health care delivery models continue to change globally, the combination of big data and associated analytic technologies have the potential to make a profound impact on our management of infectious diseases in children.

Declaration of interests

None to declare.

Contributors

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