

# INTEGRATION OF DATA SCIENCE FOR TIMELY TUBERCULOSIS (TB) CARE

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Data Science is an emerging discipline. Ubiquitous digitalization, the consequent generation of ‘big’ data, the capability to process the data, and the semiotics of its translation to innovate solutions to problems in healthcare and other domains are catalysts of its rapid growth. Digitalization is generating voluminous streams of numerical, textual, visual, auditory, haptic, and other types of data about our bodies, the things we use, and what we do where and when. Data Science is the science of translating this data into information, meaning, interpretation, knowledge, action, feedback, and learning. Systematically mining this large volume and variety of data can yield novel insights and innovative systemic solutions to current healthcare problems.

The current design of tuberculosis (TB) care system is dominated by the biological, medical, economic, and social sciences. Each addresses a significant part of the problem. Despite large-scale, long-term efforts with micro-biological diagnoses, medical treatments, economic incentives, and social protection for TB care in India, the problem of epidemiology and endemicity of TB persists and continues to worsen. Complementing these traditional sciences with Data Science can help systematically transform the TB care system by integrating it. Among the many transformations, Data Science can help deliver timely care.

Timeliness is central to effective TB care – delayed, uncoordinated, unscheduled care is not just ineffective; it compounds the problem of case management and coordination among ambulatory, community, and home facilities and their associated workforces. Data Science opens unique opportunities to assure timely, coordinated, and scheduled care and improve its effectiveness. India is moving rapidly to develop a national digital health infrastructure; it also carries a very high, growing burden of TB care. In this essay, we discuss how integration of Data Science with the other sciences for TB care can lead to: (a) timely identification, counselling, treatment, correction, and conclusion of care for, (b) individuals, families, communities, and the public. The logic of the essay is encapsulated in the Ontology of Integration of Data Science for Tuberculosis (TB) Care in Figure 1. The essay is in five sections corresponding to the five stages of TB care in the ontology. The discussion in the five sections is based on the concepts of a learning surveillance system for TB<sup>1</sup> and Active Case Finding for Ending TB in India<sup>2</sup>.

### **Data Science for Timely Identification**

The earlier a TB patient is identified and diagnosed, the shorter and more effective his/her treatment is likely to be. It would be even better if a patient is proactively managed to prevent them from becoming a TB patient – a salvage case. Timely Identification requires timely finding of patients through screening and contact tracing. These in turn are dependent on appropriate sensitization and prevention measures. The latter include assessment of risk factors, infection control, vaccination, and communication for education and behavioural change.

Data Science can be a powerful tool for screening and contact tracing, as has been demonstrated during the Covid-19 pandemic. Complementarily, Data Science can also be deployed to target sensitization and prevention measures to individuals, families, communities, and the public based on their biological, medical, social, and economic risk profile. More importantly, Data Science can be used to increase the precision and personalization of the risk profiles and hence timely identification of patients by integrating the biological, medical, social, and economic data about a target entity. Data Science can immensely improve Active Case Finding.

TB Care				
[Integration of]	Science	Stage	Entity	[TB care]
	Biological	Identification	Individual	
	Medical	Counselling	Family	
	Social	Treatment	Community	
	Economic	Correction	Public	
	Data	Conclusion		
[science for timely]		[of/for]		

**FIGURE 1: ONTOLOGY OF INTEGRATION OF DATA SCIENCE FOR TUBERCULOSIS (TB) CARE**

### Data Science for Timely Counselling

Ideally, the counselling of TB patients must be end-to-end from primordial prevention to relapse prevention, and continuous. Such counselling is essential to assure adherence by the patients to the treatment protocol despite the difficulty of doing so. Counselling can: (a) provide a treatment roadmap to the patients, (b) explain the challenges and help overcome them, (c) assuage their fears and anxieties, (d) address the personal, family, social, and professional stigma associated with TB, (e) help navigate logistical, financial, geographical, and temporal barriers to treatment adherence, (f) avoid extreme personal life-threatening feelings and measures, and (g) provide hope and encouragement for successful completion of the treatment. Timely counselling is a key to people-centred treatment: protect the life of the patient, alleviate his/her suffering, and control his/her future.

Timely counselling will be effective when it is based on the feedback and learning from the counselled – an individual, a family, a community, or the public. It can help adapt the counselling to the different stages of TB care, manage the dosage, and its focus. It will also be effective when it integrates the evidence from the biological, medical, social, and economic sciences. Data Science can reduce the cycle-time of feedback and learning, help target it with precision, and personalize it. Data Science can help integrate and apply biological, medical, social, and economic data about an entity for effective counselling and continuum of care under various socio-economic circumstances.

## **Data Science for Timely Treatment**

The TB care protocol can be complex and multi-stage. The cascade of care must be adapted based on the patient's response and must be adhered strictly. Timely treatment intervention is critical to the successful conclusion of the protocol and completion of uninterrupted treatment. Delays may not only delay the conclusion of the treatment but may also compound the problem. The timely treatment must be sustained despite the many logistical, financial, geographical, and temporal barriers.

Data Science can aid to make the treatment supply network more effective and efficient for both care provider and the receiver. It can help optimize the virtual/physical treatment balance, appointment scheduling, patient transportation, and medication delivery. The optimization may be at the level of the individual, family, community, and the public at large. Data Science can help integrate the long and complex processes of care-seeking, diagnosis, linkage to care, and treatment initiation for effective and uninterrupted treatment.

## **Data Science for Timely Correction**

Often, the progression of TB is a consequence of inappropriate and/or inadequate treatment, including drug susceptibility methods for selecting effective regimens. To overcome low predictability associated with clinically irrelevant and low reliability results of drug susceptibility testing adopted, it is important to proactively recognizing non-compliance with treatment protocol, and non-adherence by patients to help prevent the progression of TB. It will enable effective treatment in resource- constrained high-burden countries.

Data Science provide the decision support to determine deviations from the trajectory, analyze the reasons for the same, and recommend the future course based on the feedback. The recommendation may reinforce improvements, continue normal movements, and redirect deteriorations in the condition of the entity.

## **Data Science for Timely Conclusion**

DRTB treatment can be long and difficult. Timely conclusion can bring necessary closure to patient and the providers. It can also motivate them by providing a target to plan the treatment regimen, motivate providers to comply with it, motivate patients to adhere to it, and correct it when necessary. Data Science can aid bring treatment to a timely conclusion in several ways. First, by collating all the data that are spread over many databases and stretched over a long period of time to arrive at a considered decision. Second, by assisting the provider and receiver monitor the trend before and after the conclusion. Third, by integrating the best biological and medical evidence to determine the conclusion.

## Digitalization of Healthcare in India

India is digitalizing rapidly in many sectors including healthcare. The digitalization is being driven by both the public and private sectors. The Central and State governments are committed to digitalization and have rolled out many successful programs that substitute physical transactions with digital ones.

India's digitalization poses both opportunities for and threats to applying Data Science for TB care. For example, the NIKSHAY TB is a national digital platform that can be harnessed for TB care in conjunction with schemes like Ayushman Bharat for healthcare, Jan Dhan for financial transactions, and systems for surveillance and vaccine administration that have been developed in response to the Covid-19 pandemic. The threats pertain to fragmentation in governance, systems, processes, personnel, location, and schedules. In addition to these, the national data protection/storage requirements may be an important threat.

Despite their gravity, the threats can be surmounted – they have been in the financial services sector, ecommerce, airlines, and even in healthcare to a limited extent. A recent example is the nationwide Covid-19 vaccination registration and administration system. In these sectors digitalization has helped penetration of services to traditionally underserved segments of the population, and to scale up the services by orders of magnitude. Data Science for timely TB care can draw lessons from these local successes. The ontology can be used to map the pathways for integrating Data Science with timely TB care, and Data Science with other sciences for such care.

### Conclusion

The time is ripe for the proposed Data Science integration for timely TB care. It must proceed in stages. While data is in the foreground of digitalization of healthcare in India Data Science for healthcare is in the background. Integrating Data Science with the other sciences is further behind in India's plans. There is no mention of integration of Data Science for TB care or for timely TB care.

The pieces are being positioned in silos. They must be put together. Data Science for timely TB care in India could be a pilot to prove the concept and subsequently extended to Data Science for TB care. The lessons of Data Science for TB care can be generalized to Data Science for healthcare in India.

### References

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