



Time to change the single-centre approach to management of patients with tuberculosis: a novel network platform with automatic data import and data sharing

To the Editor:

Ending the global tuberculosis (TB) epidemic by the year 2035 is one of the most ambitious goals of the World Health Organization (WHO). The WHO strategy is based on three major pillars: improving TB prevention and care, supporting bold policies, and enhancing research and innovation [1]. A better understanding of TB epidemiology, enhanced retention in care and employment of standardised regimens are mandatory to get closer to TB eradication both in low- and high-prevalence countries [2–5]. Mathematical modelling can be a useful tool to understand epidemiology and control of TB in low-prevalence countries, thus leading to better approaches in terms of public health interventions [6]. In this tough challenge for clinicians, the key actions are early diagnosis of TB patients with symptoms or signs suggestive for TB within migratory flux through a nation, and tracking of these patients as well as dealing with increased TB presentation in iatrogenically immunocompromised patients [7, 8]. Low-cost interventions aimed at improving patient-contacts recording, containing outbreaks, and enhancing adherence to diagnostic work-up and follow-up are welcome to better manage the disease burden [9]. Furthermore, a dramatic improvement in diagnostic paths and therapeutic approaches is needed nationally and globally to reach the WHO endpoint [10]. Therefore, healthcare providers who take daily care of TB patients require proper tools to access comprehensive data, for managing patients during follow-up, and for data collection and analysis in multicentre observational clinical trials (MCTs) [11].

The TB Genova Network platform (www.tbnetwork.it) was developed in 2016 and it is currently online. It allows recording of TB patients' data and tracking of their transfer to other hospitals or outpatient services within the network. To date, the two adult infectious disease departments of the metropolitan area of Genoa, Italy, (Policlinico San Martino and Ospedali Galliera) are implementing the platform, while other services (e.g. the Pneumology Dept and the Outpatient Service for Immigrants) have committed to join the network. Patients' administrative data are saved anonymously through a secure HTTP protocol that assures a secure data transfer on the Internet. Personal information such as date of birth, sex, nationality, number of cohabitants (adults and children), risk factors for TB (e.g. smoking, drinking, diabetes, HIV and exposure to silica) can be recorded. A postal code can be added to facilitate mapping. After registering personal information, clinical data such as patients' symptomatology on admission, anthropometric information, comorbidities and TB localisation can be stored. Laboratory tests performed during the hospital stay and follow-up can be automatically loaded onto the platform. Simple diagrams make it easy to follow weight changes, and liver and renal function parameters, thus facilitating early side-effect identification and trend monitoring (figure 1). Imaging results can be uploaded on the platform as well, thus becoming quickly available for comparison or online advices. For those patients who are HIV–TB co-infected, specific information about the HIV immune–virological status, treatment, *etc.*, can be automatically loaded from the already-running online Ligurian HIV Network, a similar regional online



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TABLE 1 Present and future functions of the TB Genova Network

Function	Automatic [#]		Notes
	Present	Future	
Anagraphic, anthropomorphic, risk factors and first visit data			Identity information and first visit data need to be entered by the physician on site
HIV information	•		
Laboratory examinations	•		
Imaging		•	
AFB, culture, GeneXpert MTB/RIF	•		
GWAS		•	
Resistance patterns		•	Definition of MDR-TB and XDR-TB will be automatically provided based on resistance patterns
<i>rpoB</i>	•		
<i>gyr</i>	•		
<i>kat</i>	•		
<i>rrs</i>	•		
Second-line drugs		•	
Treatment/treatment modifications		•	
Follow-up		•	
Outcome			Healthcare providers can mark a TB-episode according to WHO definitions [13]

TB: tuberculosis; AFB: acid-fast bacillus; GWAS: genome-wide association study; MDR: multidrug-resistant; XDR: extensively drug-resistant. [#]: all automatic data can be manually stored and modified.

platform [12]. Microbiological and molecular examinations can be registered and successfully tracked for each patient. Data on the anti-TB regimen are also collected, with initial and final date of drug administration, number of missing doses, and motivation for treatment switch, discontinuation or termination (figure 2). Links to major drug interaction checker websites are easily available on the platform to help avoid possible drug–drug interactions. Follow-up can be periodically reported. A visual interface supports and simplifies the report of side-effects and weight variations. To enhance visual impact, chromatic alerts of microbiological parameters have been added. Particularly for sputum, a red colour highlights a positive or in progress mycobacterial culture, while a green colour highlights a negative culture for *Mycobacterium tuberculosis*. All data can be both uploaded on the website or, since they are already available on the Laboratory Information System, automatically imported from the hospitals' databases (table 1) [14]. The database was approved by the Comitato Etico Regionale Ligure on September 22, 2016.

In the first year of the project, 60 cases of TB (40 pulmonary and 20 extrapulmonary; 26 born in Italy and 34 foreigners) were recorded. This project represents an important effort to collect clinical, laboratory, radiological and therapeutic data about TB patients that can be used for both clinical and research purposes. The system minimises the risk of an incongruous duration or type of therapy for patients that decide to change their referral clinical centre. Importantly, when a patient is taken into care by a new centre after being lost to follow-up, all past data on their therapeutic history and any known TB resistance are readily available, and patients do not risk a delay in proper management. Second, the intuitive

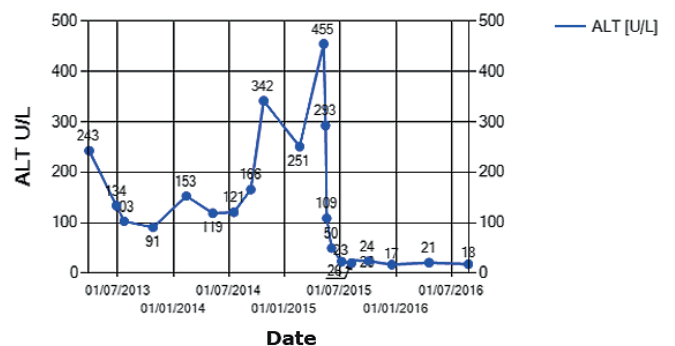


FIGURE 1 Example of alanine aminotransferase (ALT) monitoring during prolonged tuberculosis (TB) treatment.

Data inizio terapia* (gg/mm/aaaa): / /

Data fine terapia (gg/mm/aaaa): / /

Somministrazioni mancate (gg):

Motivazione fine terapia: [HEP Drug Interaction](#) [HIV Drug Interaction](#) [Drug Interaction](#)

AGENTI ORALI DI PRIMA LINEA	Dose totale	Unità misura	Numero compresse/fiale
<input type="checkbox"/> Etambutolo (E)	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="checkbox"/> Isoniazide (Inh)	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="checkbox"/> Rifabutina (Rfb)	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="checkbox"/> Rifampicina (Rfp)	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="checkbox"/> Pirazinamide (Z)	<input type="text"/>	<input type="text"/>	<input type="text"/>
A: FLUOROCHINOLONI			
Fluoroquinoloni [Seleziona-]	<input type="text"/>	<input type="text"/>	<input type="text"/>
B: AGENTI INIETTABILI II LINEA			
Agenti iniettabili II linea [Seleziona-]	<input type="text"/>	<input type="text"/>	<input type="text"/>
C: ALTRI AGENTI DI SECONDA LINEA			
<input type="checkbox"/> Linezolid (Lzd)	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="checkbox"/> Clofazimina (Cfz)	<input type="text"/>	<input type="text"/>	<input type="text"/>
Etionamide/Protionamide [Seleziona-]	<input type="text"/>	<input type="text"/>	<input type="text"/>
Cicloserina/Terizidone [Seleziona-]	<input type="text"/>	<input type="text"/>	<input type="text"/>
D1: AGENTI AGGIUNTI			
<input type="checkbox"/> High dose Isoniazid (Hh)	<input type="text"/>	<input type="text"/>	<input type="text"/>
D2: AGENTI AGGIUNTI			
<input type="checkbox"/> Bedaquilina (Bdq)	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="checkbox"/> Delamanid (Dlm)	<input type="text"/>	<input type="text"/>	<input type="text"/>
D3: AGENTI AGGIUNTI			
<input type="checkbox"/> Acido Amminio-salicidico (PAS)	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="checkbox"/> Imipenem-cilastatina (Ipm)	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="checkbox"/> Meropenem Amoxicillina-acido clavulanico	<input type="text"/>	<input type="text"/>	<input type="text"/>

FIGURE 2 Tuberculosis treatment front page.

interface of the platform makes it easy to use for both input and data consultation, even for untrained users. Third, daily acquisition of laboratory results from hospital software is fully automatic and includes visual alerts to identify microbiological results. However, other clinical information must be added manually, with possible errors; this is mostly due to the limited diffusion of electronic medical records. Another weakness is the absence of an automatic alarm system to inform the clinician of missed follow-up visits, laboratory examinations or imaging studies because of the heterogeneity of follow-up programmes that need to be tailored to a single patient. Similarly, an alert for undelivered drugs might be useful. Future implementations might consist of regional and national distribution of the platform in order to better understand the challenge that TB poses at both local and national levels. Currently, in the Ligurian region, every TB case is notified through a paper document; however, other Italian regions are using online platforms to allow faster TB surveillance. The TB Genova Network may be connected to central surveillance systems to provide updated online surveillance data.

The TB Genova Network can support healthcare workers in administrating patients' data within primary care, in order to improve patients' treatment outcomes and retention in care. Focusing on epidemiological and clinical aspects of TB, the TB Genova Network differs from other online platforms and allows every user to recall clinical data about the patients' TB episodes. In addition, collected clinical information can be used to perform observational MCTs. Although current diagnostic procedures are all included in the network (*e.g.* sputum smear microscopy, sputum cultures, GeneXpert, *etc.*), any new diagnostic approach for active TB diagnosis, including genome-wide association studies, may be updated and uploaded on the TB Genova platform to improve the quality of recorded data [15]. As SOTGIU and MIGLIORI suggested [16], better data will bring more tailored therapies for TB.

The TB Genova Network is an online tool to standardise and unify individual databases in Genoa, preventing data waste and ensuring anonymity for patients. This network is the first Italian online cohort of active TB and database for managing TB patients during the diagnostic work-up and during follow-up.

Extended national and international networks collecting information on diagnosis, management and outcomes of patients with active or latent TB infections can be useful tools to help reaching the WHO goal of ending global Tuberculosis epidemic by the year 2035 [1].

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