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Review Article

Development of a Conceptual Framework for Tuberculosis Management and Control; an Evidence Synthesis using Text Mining Software: A Review

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Abstract

Background: The use of electronic systems supported by text-mining software applications that support the End TB strategy' needs to be explored. This study aimed to address this knowledge gap, and synthesis of evidence.

Methods: The PubMed database was searched for structured review articles published in English since 2012 on interventions to control and manage TB. Nine hundred twenty-five articles met the inclusion criteria. The included articles were synthesized using the text and content analysis software Leximancer. The themes were chosen based on the hit words that emerged in the frequency and heat maps. After the themes were chosen, the concept built the themes based on likelihood.

Results: The framework resulting in the study focuses on early detection and treatment to minimize the chance of TB transmission in the population, especially for highly susceptable populations. The main area highlighted is the appropriate screening and treatment domains. The framework generated in this study is somewhat in line with the WHO Final TB Strategy. This study highlights the importance of improving TB prevention through a patient-centered approach and protecting susceptible populations.

Conclusion: Our findings will be helpful in guiding TB practice, policy development and future research. Future research can elaborate the framework and elicit feedback from TB management stakeholdesr to assess its utility.

Keywords: Tuberculosis; Automatic knowledge; Framework; Control; Management

Introduction

Tuberculosis (TB) is the second leading cause of global mortality from infectious diseases. In 2020, the WHO estimated that there were 10 million people infected with TB worldwide (1). Multi-drug-resistant TB (MDR-TB) represents a particularly acute global health security threat, with only one in three people accessing gold standard therapeutic treatment (1-3).

To eliminate TB, the WHO established the 'END TB by 2035 Program', with the goal of zero death, disease, and suffering due to TB by the year 2035 (4). As articulated by the WHO,

key areas to achieve this goal include improvements in relation to early diagnosis and access to effective treatment, the development and implementation of evidence-based health system policies, as well as the promotion and intensification of research to inform the policy agenda (5).

Many risk factors increase TB transmission in a community. The WHO TB prevention and control guidelines focus on three areas: administrative controls, environmental controls, and respiratory protection. Administrative controls measure specific interventions targeted at reducing exposure and transmission of TB. They relate to management of patient flows to promptly identify and separate presumptive TB cases (6).

In terms of environmental controls, unsafe indoor environments in high congregate settings, and overcrowding in general, are most critical (7). Finally, respiratory protection is focused on reducing TB transmission to health workers, people attending health care facilities, or people in other settings with a high risk of transmission (6). Several systematic reviews have showed evidence of the presence and impacts of TB risk factors (8–10). However, the relationships between key factors remain largely underexplored in the research literature. This literature review study aimed to address this knowledge gap by identifying these relationships visually, using innovative text mining software, to inform the TB research and policy agendas.

Methods

This review was conducted in 4 steps (11): 1. Identifying the research question, 2. Data collection, 3. Data analysis, and 4. Result interpretation (Fig. 1).

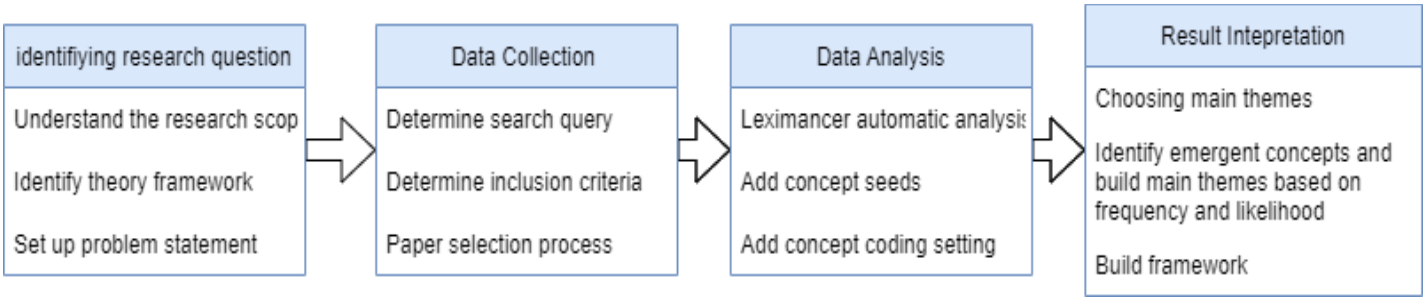

Fig. 1: Four stages of the research process

The authors' prior research and policy expertise regarding TB informed the development of the research question, which is 'what are the types of risk factors, and relationships between them, that need to be considered for development an effective control and management strategy for TB?'

The authors searched the PubMed research database using the query, ((TB OR TBC OR Tuberculosis) AND Risk Factor). The keyword was based on the Medical Subject Heading (Mesh) related to TB. Because this was an innovative pilot study, only one database was searched. Further studies are planned that will involve searching additional research databases. The inclusion criteria were: published in the past 10 years, English language, and any form of structured literature review (e.g. systematic reviews, scoping reviews). The resulting studies were screened by the authors based on title and abstract, then full text, in line with established literature review methods (Fig. 2). The database search was completed in Jan, 2022.

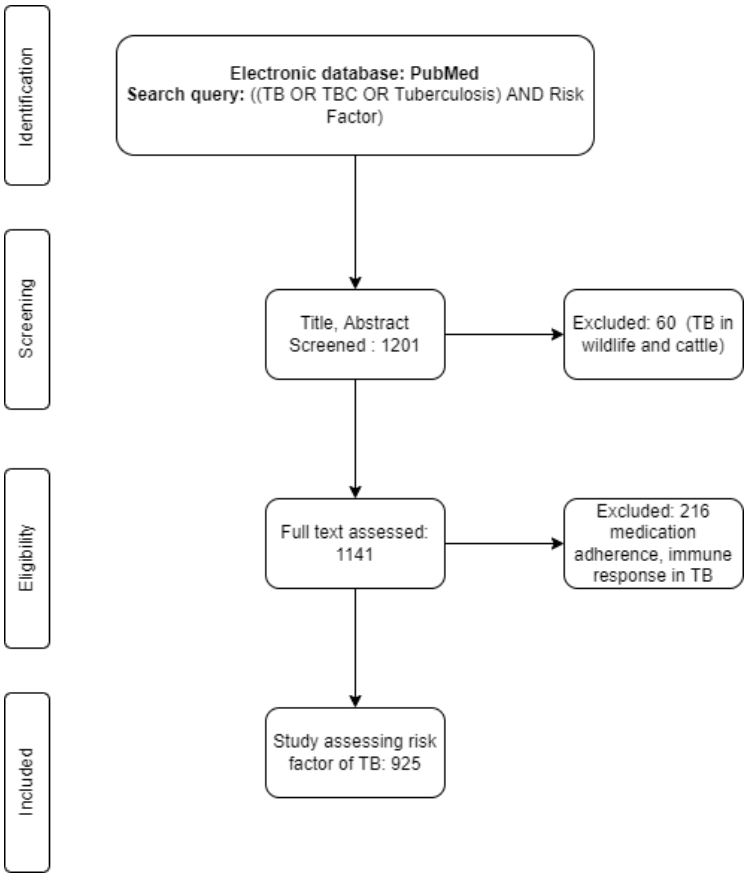

Fig. 2: PRISMA Process of inclusion and exclusion of relevant articles

The final set of included studies were then subjected to data extraction to identify information related to the above-mentioned study aims. Of the 1201 papers initially identified, 276 did not meet the inclusion criteria (Fig. 2). The remaining 925 included papers were then subjected to analysis using the Leximancer text and content mining software.

Leximancer assists the examination of texts—words, and word segments—and produces a thesaurus of essential terms, known as textual concepts (12). The software enables the review of the link and network between concepts in major text documents. Sets of the most strongly related concepts are determined as themes. Leximancer generates a ranked list of themes and a visual map of their relations, containing details of both the intensity of a concept as it recurs within the text and the extent of link to other concepts. The Leximancer program splits textual material into its key categories (themes, concepts) in order to visualize and quantify the text (12).

The use of Leximancer was viewed by the authors as having the potential to eliminate the bias and subjectivity that arises from typical qualitative, thematic analysis within many types of structured literature reviews (13). The authors are unaware of any prior TB research that has utilized this innovative software to facilitate evidence synthesis.

The researchers maximized the first result of the themes provided by Leximancer by excluding meaningfully-insignificant themes such as “the”, “tion”, “con’, “de”, “ing”. Words that have the same meaning, such as “activity” and “activities”, were merged in the concept seeds setting. The configuration setting in Leximancer affected the number of themes constructed. We used the available setting of 33% of both theme and concept size to generate best result.

The themes were chosen based on the hit words that emerged in the frequency and heat maps. After the themes were chosen, the concept built the themes based on likelihood. Likelihood means how close the concept is related to the theme. The higher the likelihood percentage, the closer the concept to the theme. After deciding the concept and word-like in concept (word-like concept appear in the text), we merged words to constitute the whole concept. The results from this analysis were discussed among the authors to collaboratively construct the final conceptual framework.

Results

The Leximancer results produced a useful overview of the content within the included articles. Twelve themes appeared (Figs. 3 and 4). The most frequents words that occurred, used to develop the final concepts, were "TB", "Patients". "Risk", "studies", "Cases".

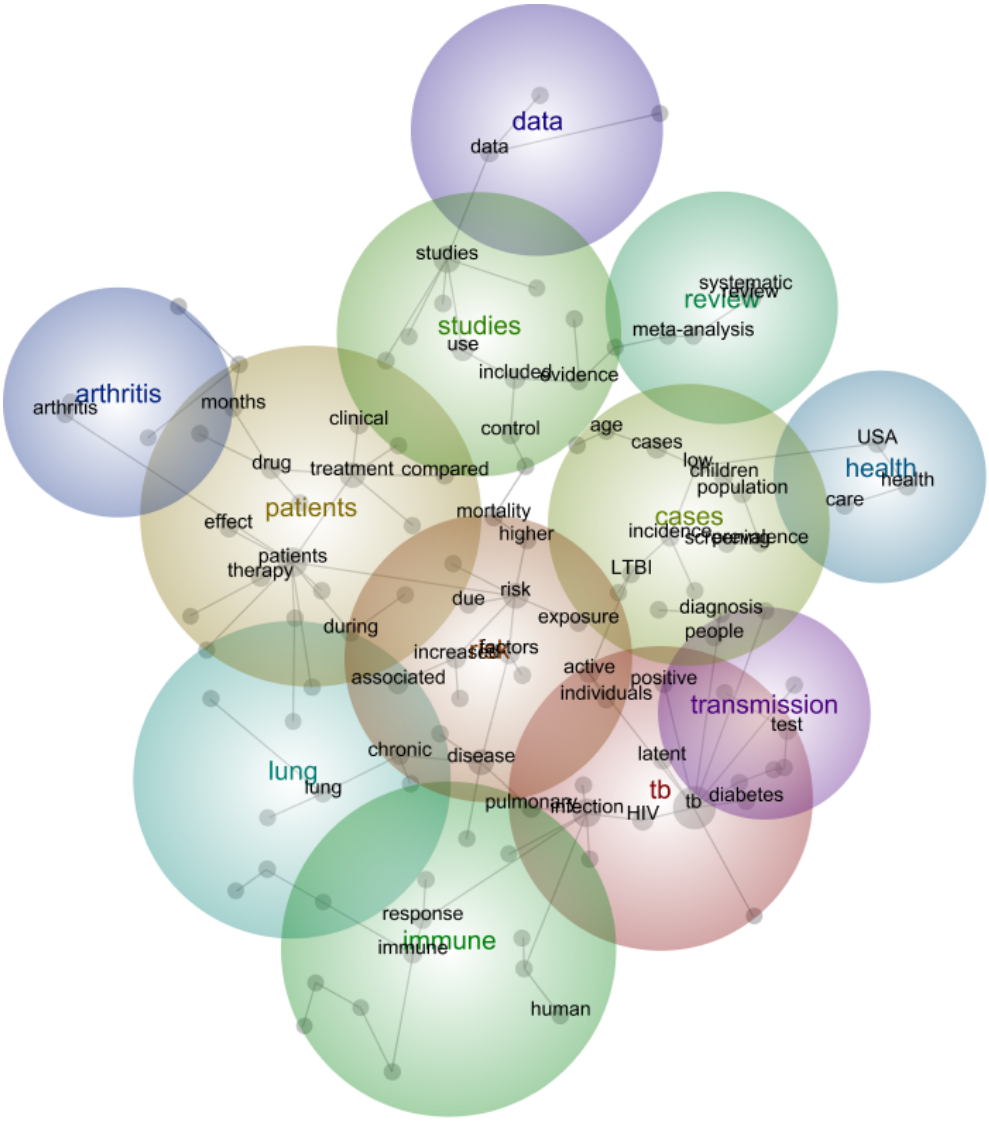

Fig. 3: Theme visualization

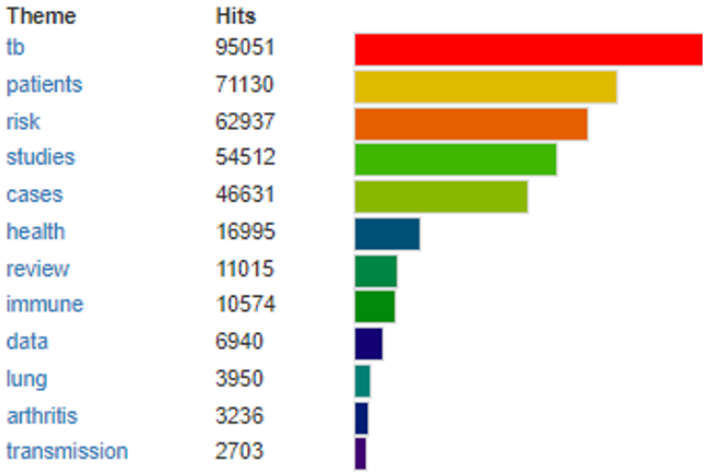

Fig. 4: Theme frequency summary

The final concept results are provided in Table 1. The 'TB' theme generated concepts of Tuberculosis, TB, latent, test, and diagnosis resulting in the final concept as TB active, TB HIV, TB latent, TB resistance, screening TB, and TB children. The theme 'Patients' produced the final concepts of patient safety, and therapy management. The theme 'Studies' produced the final concepts of population susceptibility, and prevalence in population. The 'Risk' theme produced final concepts of increased risk factors, increased risk transmission, and mortality. The 'Cases' theme resulted in the final concepts of incidence control, and case management.

Table 1: Concepts chosen, based on likelihood and frequency

Theme	*Concept*	*Likelihood*	*Resulting concept*
TB	Tuberculosis, HIV, Latent, Test, Diagnosis	Latent, Active, Pulmonary, Transmission, Burden, Susceptibility, Diagnosis, Incidence, Screening, People, Infection, Diabetes, Resistance, Testing, Control, Adult, Children, Early, System, Management, Therapy,	TB Active, TB HIV, Latent TB, TB Children, TB Adult, TB Resistance, Screening TB, Early Testing TB, TB Therapy Management, TB System Management
Patients	Patients, Treatment, Factors, Therapy, Drug, Clinical, Effect, Treated, Months, Significant	Safety, Phase, Therapy, Agents, Severe, Early, Management, Resistance,	Patients' Safety, Effect Patients' Therapy, Patients' Therapy/Treatment Management,
studies	Studies, Use, Included, Reported, Data, Results, Analysis	Cohort, Prevalence, Population, Susceptibility,	Prevalence in Population, Population Susceptibility, Reported
Risk	Risk, Associated, Increased, Higher, Compared, During, Due, Mortality, Rate	Increased, Factors, Cancer, Transmission,	Increased Risk Factors, Increased Risk Transmission, Mortality
Cases	Cases, Population, Control, Low, Incidence, Evidence, LTBI, Age, Exposure, Number	Reported, Number, Treated, Management,	Incidence Control, Cases Management

Based on the resulting concepts that emerged from the Leximancer-enabled analysis of the included studies, a conceptual framework of TB control and management was developed (Fig. 5). The framework has two main foci: screening, and appropriate treatment. The focus of the framework is on early detection and treatment to minimize the chance of TB transmission in the population, especially for highly susceptible populations. Key elements of the framework are outlined below.

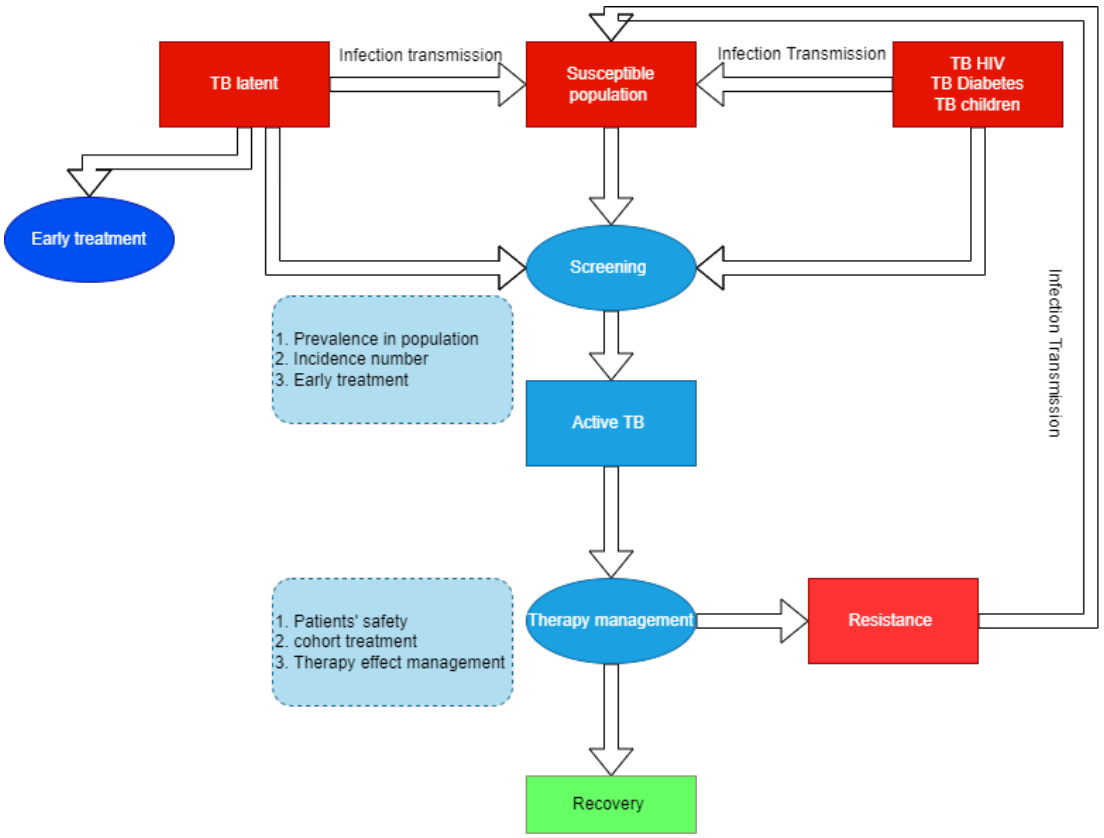

Fig. 5: The conceptual framework of TB control and management

Screening

Screening is the systematic identification of people at risk for TB disease, in a predetermined target group, by assessing symptoms and using tests, examinations or other procedures that can be applied rapidly (3). Screening can help health providers understand the TB burden in a population (14).

The conceptual framework produced in this study suggests that screening should target three main groups: TB latent (that is, non-symptomatic) individuals, susceptible populations, and individuals with TB related diseases, such as TB-HIV and TB-Diabetes. Screening for latent TB infection and initiation of preventive treatment to reduce the possibility of reactivation is suggested by WHO as part of the global strategy to End TB (15). One-third of the global population has latent TB, and 5-10% will develop TB disease within the first five years after initial infection. However, the risk is considerably higher for individuals with predisposing factors, such as HIV infection (16).

The second group is the susceptible population, defined as populations with high-risk of TB infection such as prisoners, migrants, people living

with HIV, and socially marginalized people (17). Active screening among migrants shows a significantly higher number of TB infection than other groups (18). Countries with high migrant populations should perform screening regularly to prevent TB transmission among this population. The third main group identified in the included articles as having high risk of TB infection and transmitted to others were diabetic patients, people living with HIV, and people with immune problems (19).

Therapy management

Within the conceptual framework, therapy management refers to not only TB drug treatment for patients, but also the management of side effects, such as lack of feeling or tingling in the hands or feet, upset stomach, nausea, vomiting, diarrhoea, or loss of appetite (20). Because of the long treatment (minimum 6 months) for TB infection, the management of cohort treatment should be provided to increase the chance of the patient getting drug resistance early (21).

Patient safety should also be priority during the course of treatment (22). In TB patients, safety most particularly concerns how to treat TB patients with the right medication and decrease the chance of developing multidrug resistant TB. Side effects are another important consideration (23). Health services should prepare a summary of the reactions reported and/or safety reviews of the anti-TB medicines being used (22). The management of therapy, such as following adherence of patients during treatment, especially for MDR-TB, has also become an important part of TB elimination (24). The proper use of TB medication will decrease the transmission of TB infection in populations.

Discussion

For countries with a high burden of TB, such as Indonesia, there is a clear need to address the challenge of elimination. Since 2016, the effectiveness of TB medication in Indonesia has consistently decreased (25). As a consequence, the number of MDR-TB cases have increased (26). Based on the joint external monitoring mission (JEMM), the treatment for MDR-TB is commonly delayed, with almost 60% of MDR-TB remains undetected, and TB preventive treatment is low in children with household TB contact (27). This concerning situation in Indonesia in similar to many other Low- and Middle-Income Countries (28-30), making it vital to develop and implement evidence-based, comprehensive health system responses.

The evidence-based conceptual framework developed in this study highlights two keys concerns regarding TB management and control; screening and therapy management. These areas align with the WHO strategic framework's first pilar, which is integrated patient-centered care and prevention (31).

When the conceptual framework produced in this study is compared to Indonesia's strategy on TB elimination (increase treatment success rate, risk factor management, surveillance, early detection, public private mix approach), several similarities emerged, including the focus on improving access to quality health services, and case identification to break TB transmission (32). However, the Indonesia TB Strategy is more focused on stakeholder collaboration to facilitate the implementation of evidence-based approaches (33).

Four dimensions of tuberculosis (TB) elimination in low-incidence countries in an action framework compared to studied framework, the differences were found in screening population which low-incidence countries provide TB tracing for migrants and cross border issue (34). However, the test and treatment become priority in both frameworks.

For these reasons, this study highlights the importance of improving TB prevention through a patient-centered approach and protection of susceptible populations. Populations with certain characteristics such as malnutrition, active smokers, and residents of areas with high levels of air pollution should be prioritized for screening (35).

In terms of limitations, the pilot study only used one research database. The study findings also

present limited information on exploring stakeholder collaboration and policy in building effective approaches to managing and preventing TB.

Conclusion

The innovative, automated approach to knowledge structure development applied in this literature review study assisted the researchers to construct a conceptual framework to support TB management, based on the academic evidence base.

In order to achieve the objectives of WHO's End TB Strategy, further understanding and refinement of the relationships between individual evidence-based approaches are required. The key findings from this study address this issue and will be helpful in guiding TB practice, policy development and future research. Future research can elaborate the framework and elicit feedback from TB management stakeholders to assess its utility.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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