

Tuberculosis Regional Training and Medical Consultation Centers in the United States: Characteristics, outcomes, and quality of medical consultations, June 1, 2010 — May 31, 2014

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ABSTRACT

Background: Tuberculosis (TB) Regional Training and Medical Consultation Centers (RTMCCs) were established in 2005 for TB medical consultation, training and education in the United States. A medical consultation database (MCD) captured all consultations provided by RTMCCs; we report on those provided from June 1, 2010 to May 31, 2014.

Methods: All MCD consultations during 2010–2014 were categorized into: provider type, setting, consultation topic, and patient age. We analyzed data frequencies and performed subgroup analyses by RTMCC, by TB incidence for the geographical area, and by year of consultation. End-user satisfaction was assessed by a 2016 telephone evaluation of RTMCC services.

Results: A total of 11,074 consultations were delivered, with 10,754 (97.1%) in the U.S. and its current or former territories. Of these, 6018 (56%) were for high, 2443 (22.7%) for medium, and 2293 (21.3%) for low TB incidence settings. Most were for adults (81.3%) and answered within 24 h (96.2%). Nearly 2/3 consultations originated from health departments; providers included mostly physicians (44.3%) or nurses (37.6%). Common consult categories included TB disease (47.7%), case management (29.8%), latent TB infection (19.3%), diagnosis (16.1%), pharmacology (14.7%) and adverse side effects (14.3%). Among adverse side effects, hepatotoxicity was most common (39.6%). Volume and nature of consult requests remained relatively stable over the four-year period. Feedback from a 2016 CDC evaluation indicated overall satisfaction with RTMCC medical consultation services.

Conclusion: RTMCCs were an important source of TB medical consultation over the time-frame of this assessment and provided quality expert consultation within 24 h. RTMCCs represent a reservoir of TB subject-matter expertise in the United States.

1. Background

Tuberculosis (TB) is the leading infectious disease killer in the world

and one of the top 10 causes of death worldwide [1]. The organism that causes TB, *M. tuberculosis*, has had great success in persisting silently in about one-fourth to one-third of the world's population causing disease

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in only 5–10% of those infected [2–4]. Acquired resistance to anti-TB medications and person-to-person airborne transmission of TB has complicated the management of this complex disease. Treatment for TB has been available since the advent of streptomycin in 1952 and, in the United States, TB rapidly declined from 84,304 cases in 1953 to 22,201 cases in 1985 and was thought to be under control until its resurgence in 1985–1992 [5–7]. The resurgence was largely associated with globalization, HIV, urban crowding, and lack of institutional infection control leading to transmission in the hospital setting, was complicated by multidrug resistance, and was marked by several years of increasing case counts until its peak in 1992. Of concern, a national survey of physician practices conducted in early 1990s found that a relatively large proportion (40.6%) of respondents reported using TB treatment regimens that were inconsistent with national TB guidelines [8]. The survey findings suggested loss of proficiency in clinical management of people with TB, coincident with declining disease trends, and the need to provide training and consultative services.

From 1992 until the present, the total number of TB cases has decreased, with the 2017 U.S. case number of 9105 being the lowest in the history [6]. This national decline in case numbers and rates is due, in part, to the response to the resurgence of TB in 1992 and 1993 when new strategies were designed and implemented and TB-specific funding was allocated by the U.S. government to effectively reverse the upward trend [9,10]. A crucial component of the national response was the establishment of three “model TB centers”, the San Francisco-based Curry International TB Center (CITC), the New Jersey-based Global TB Institute (GTBI), and the New York-based Charles P. Felton TB Center, for providing medical consultation and training and education for TB care and management in the United States.

Based on the utilization and success of these three centers from 1995 to 2005, the Centers for Disease Control and Prevention (CDC) regionalized and expanded the concept by establishing four Tuberculosis Regional Training and Medical Consultation Centers (RTMCCs) in 2006. These centers were geographically selected to serve the needs of the entire country and four centers, CITC, GTBI, the Southeastern National TB Center (SNTC), and the Heartland National TB Center (HNCTC), were selected through a competitive application process and funded through a cooperative agreement with CDC of \$6 million/year for a 5-year period starting in 2006. In 2013, with the second open competitive cycle, a fifth center, the Mayo Clinic Center for Tuberculosis (MCCT), was added through 2017. These centers have provided expert medical consultation for the United States on a regional basis with each center covering a specific number of states within the same geographic area in which it is located. Expert medical consultation consists of a telephone or email communication between an RTMCC expert physician or nurse and a provider of TB care regarding any question related to TB care and management.

The concept of the provision of regional expert medical consultation for the care and management of TB patients and their contacts was based on the finding that expert medical consultation may be associated with better patient outcomes and the documented need for such consultation [11,12]. To systematically document, characterize, account, and provide opportunities for review and quality assurance for the variety of medical consults provided by each RTMCC, response to queries were documented in written form. The results were to also provide surveillance and guide the nature of training and education services by RTMCCs. Each center has provided consultation to physicians, nurses and other health care providers in their region using three to twenty-two expert consultants who have taken calls on a rotational basis. There were slight differences in the models for clinical consultation between centers; however, each center has consistently aimed to provide the service of quality expert consultation within a 24-hour period; urgent requests for response within 2 h were also provided by SNTC.

After months of development, tests, and refinements, the Medical Consultation Database (MCD) was launched for SNTC in September

Table 1
International versus domestic calls.

All calls	=	11,074	%
– US and territories	=	10,754	(97.1)
– International	=	316	(2.8)
– NA	=	4	(0.1)

Consultations provided for domestic versus international callers over the study period.

Table 2
Overall calls stratified by TB Incidence of caller's jurisdiction.

Incidence	Frequency	Percent (%)
High	6018	56.0
Medium	2443	22.7
Low	2293	21.3
Total	10,754	100.0

Consultations provided over the study period stratified by TB incidence of caller's jurisdiction (high > 800 cases per year, medium 100–800 cases per year, or low < 100 cases/year).

2006. Extensive training was conducted for all staff and, after initial implementation in Florida, the service was expanded to the entire Southeast region in the final 3 months of 2006. Marketing plans were initiated targeting all states and territories in the Southeast Region to increase awareness of the 24/7 medical consultation service, also known as “the Hotline”. An end-user survey asking about the quality and timeliness of consultation, and peer-to-peer case-based monthly conference calls were also implemented.

After the MCD was established at SNTC, this database was expanded to all RTMCCs to assure complete capture of details of each consultation for quality assurance, training and education and the documentation of recommendations for ongoing consultation. In 2008, a small group was formed to develop the MCD tailored for the needs of each RTMCC, defining the variables to be captured, the timeline for development by SNTC, and implementation in the other RTMCCs. Between 2008 and 2010, the MCD was implemented in each RTMCC and modified for differences in the method of provision of expert consultation specific to each center.

In 2012, the CDC Division of TB Elimination (DTBE) was asked by the CDC Division of Global Migration and Quarantine (DGMQ) to provide medical consultation for physicians evaluating U.S.-bound refugees and immigrants using the 2009 *Technical Instructions for Tuberculosis Screening and Treatment* (TBTI) [13]. A workgroup defined the variables to be captured and a separate silo was created in the MCD to capture data specifically for this consultation service.

Outcomes and impact of this model of medical consultation through the RTMCCs have previously been described for pediatric consultations [14]; this report describes outcomes and impact for all consultations continuously provided by the RTMCCs for the United States and for the DGMQ overseas screening program, June 2010–May 2014. This time-period was chosen because all centers had transitioned to using the MCD by June 2010.

2. Methods

The CDC MCD was queried for all consultations provided by the RTMCCs from June 1, 2010 through May 31, 2014. Variables analyzed included provider type, provider occupation, pediatric versus adult consultation, TB-related topic area, and turn-around-time for response. If the topic area was adverse drug reactions, the data were further stratified by type of reaction. Topics were not mutually exclusive (more than one topic could be selected per consultation), topic classification was up to medical consultant and thereby not standardized within or

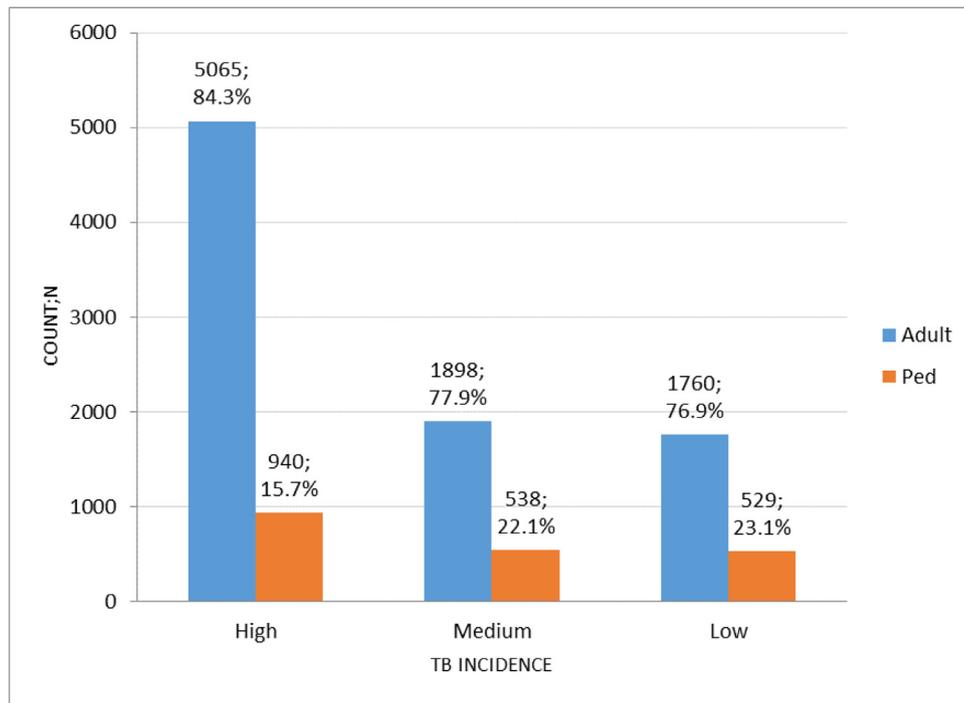


Fig. 1. Adult versus Pediatric Consultations Stratified by TB incidence

Adult versus pediatric consultations stratified by TB incidence of caller's jurisdiction (high > 800 cases per year, medium 100–800 cases per year, or low < 100 cases/year).

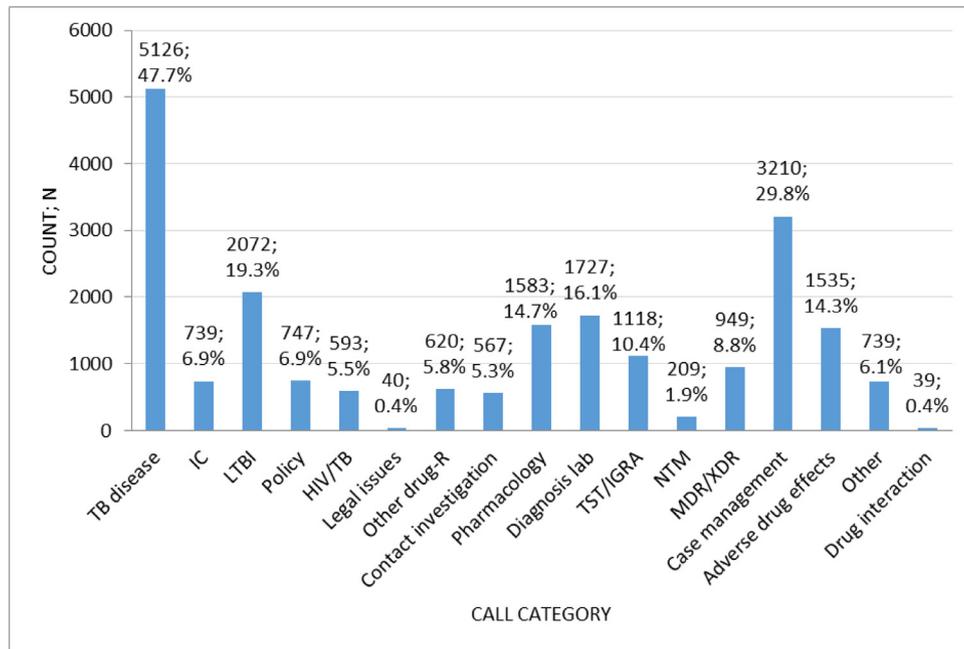


Fig. 2. Topic Areas for Consultations (n = 10,754)

Topic Areas for consultations (not mutually exclusive)

IC- infection control

LTBI – latent TB infection

TST – tuberculin skin test

IGRA – interferon Gamma Release Assay

NTM- nontubercular mycobacteria

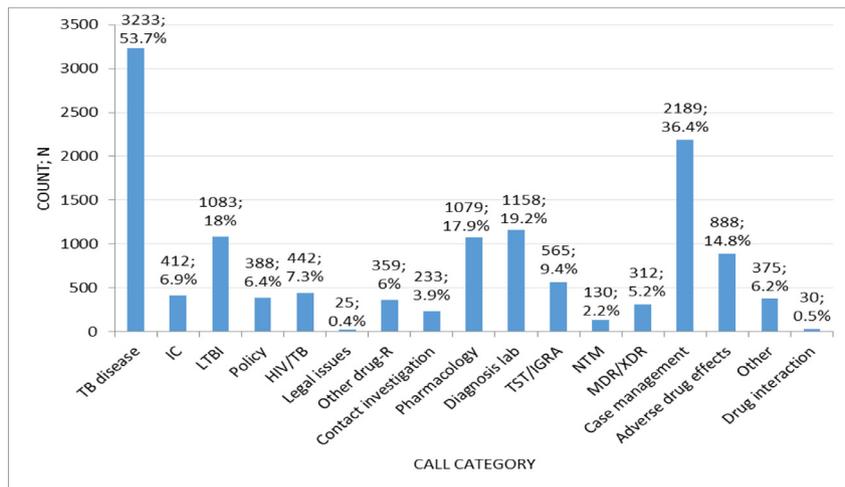
MDR- multidrug-resistant

XDR- extensively drug-resistant.

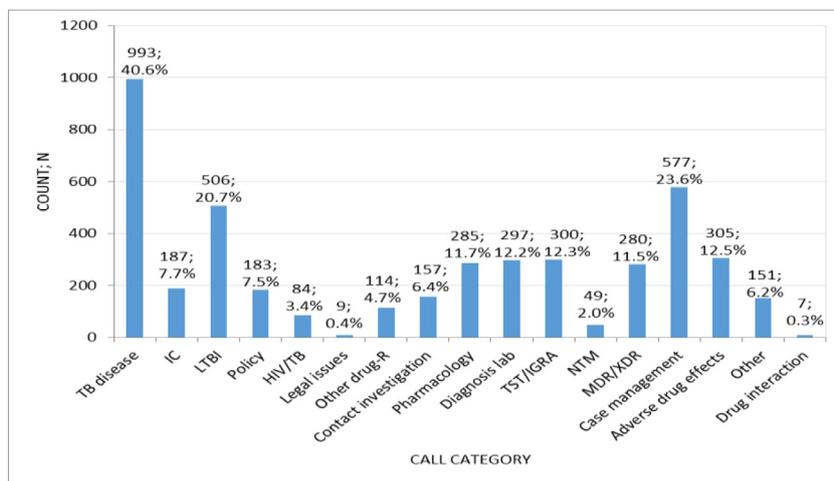
between centers, and more than one consultation could be provided for the same patient. Turn-around-time was measured by the percentage of consultations that were provided within the time frame of 2 h, 24 h or

48 h and was recorded in the MCD from the time of initiation of the consultation request to the time when the medical consultant submitted the consult in the system as complete. Subgroup analyses were

High



Medium



Low

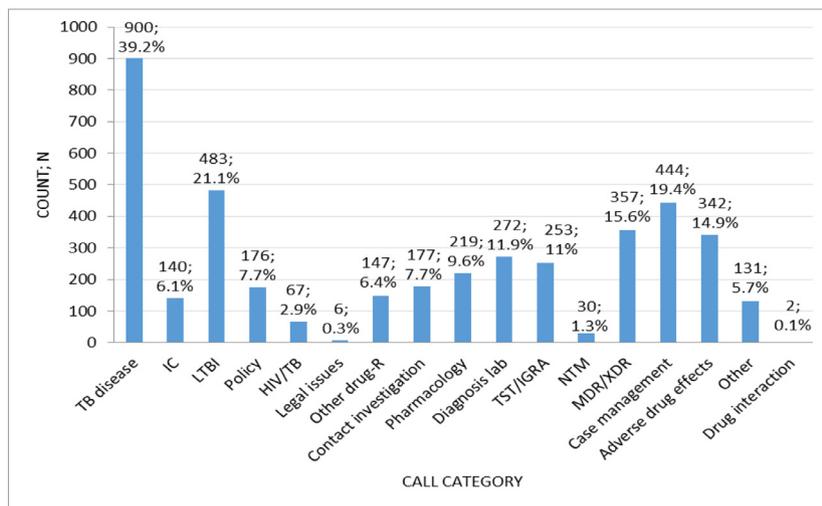
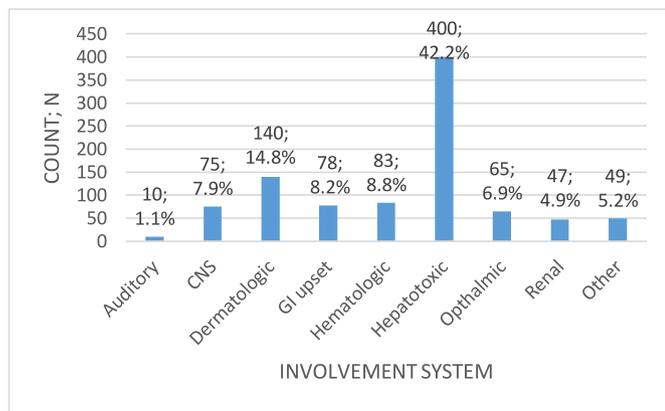
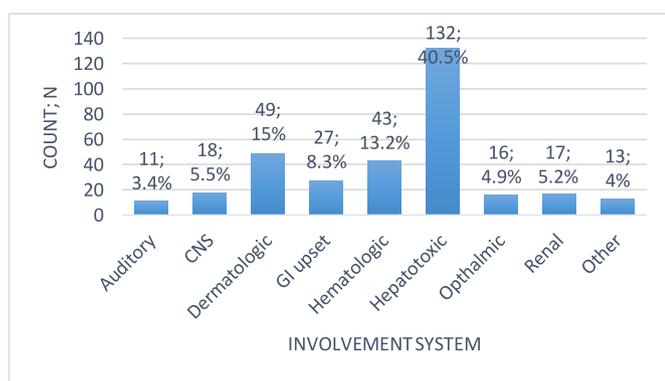


Fig. 3. Topic Areas for consultation stratified by TB Incidence
 Topic Areas for Consultations (n = 10,754) stratified by TB incidence of caller's jurisdiction (high > 800 cases per year, medium 100–800 cases per year, or low < 100 cases/year).

High



Medium



Low

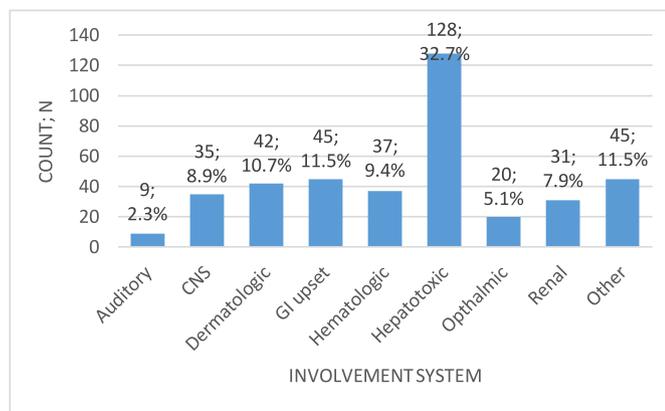


Fig. 4. Adverse side effects reported stratified by TB incidence of caller's jurisdiction

Adverse side effects reported stratified by TB incidence of caller's jurisdiction (high > 800 cases per year, medium 100–800 cases per year, or low < 100 cases/year).

performed to track changes in consultation practices by region, by TB incidence of geographical area, and over time. Overseas consultations were analyzed similarly. States were defined as having high (> 800 cases per year), medium (100–800 cases per year), or low (< 100 cases/year) TB incidence based on the average case count per year over the four-year period. Data were analyzed by MCCT using Microsoft Excel.

CDC conducted an evaluation to assess satisfaction with the services provided by the RTMCCs by performing telephone interviews with all TB programs funded through the CDC cooperative agreement between

December 2015 and May 2016 [15]. Questions were developed by the CDC RTMCC project team and telephone interviews were conducted by members of the team and were approximately an hour in duration.

Ethics: Ethical review by CDC was obtained for this evaluation, which was determined to be program evaluation activity, not human subjects research requiring institutional review board (IRB) approval. Ethical approval was similarly obtained from Mayo Clinic IRB as not human subjects research requiring IRB approval.

3. Results

The total number of consultations provided by the RTMCCs between June 1, 2010 and May 31, 2014 was 11,074, with 10,754 (97.1%) being provided for the United States and its territories, 316 (2.8%) being provided for international callers and 4 without data (0.1%) (Table 1). Of the domestic consultations, 6018 (56%) were provided for high, 2443 (22.7%) for medium, and 2293 (21.3%) for low TB incidence settings (Table 2).

Most consultations were provided for adult patients (81.3%) with fewer for pediatric patients (18.7%), though the proportion of pediatric consultations provided was slightly higher in medium (22.1%) and low (23.1%) incidence jurisdictions (Fig. 1). Overall, categories of medical consults were, in descending order: TB disease (47.7%), case management (29.8%), latent TB infection (LTBI) (19.3%), diagnosis (16.1%), pharmacology (14.7%) and adverse side effects (14.3%) (Fig. 2), and this distribution was similar across high, medium, and low jurisdictions. However, a disproportionately larger proportion (15.6%) of medical consultations in low incidence jurisdictions were concerning multidrug-resistant/extensively drug-resistant (MDR/XDR)-TB (Fig. 3). Among calls concerning adverse side effects, hepatotoxicity was the most common (39.6%), regardless of TB incidence in the jurisdiction of the caller (Fig. 4).

Callers were mostly from state and local health departments (64.8%), followed by hospitals (10.9%) and private practitioners (8.4%) (Fig. 5). There was some variability in these numbers between high, medium and low incidence jurisdictions, specifically with more calls from State Health Departments than Local Health Departments in low incidence jurisdictions, but the overall proportion remained similar. Callers were generally physicians (44.3%) or nurses (37.6%) regardless of TB incidence in their jurisdiction (Fig. 6). Most consultations were provided within 48 h (69.2%), and 96.2% were provided within 24 h, regardless of TB incidence. The over-time number of calls per year (Fig. 7) and all other variables were relatively constant over the four-year study period.

There were some significant differences between RTMCCs. HNTC provided the greatest number of consultations (60.7%) (Fig. 8) and “case management” was 5 to 6 times more likely to be chosen as a topic area; otherwise there were only slight differences in the distribution of consultation topic areas per center (Fig. 9). The distribution of calls from high, medium, and low incidence jurisdictions demonstrates HNTC (69.4%) and CITC (59.7%) took most calls from high incidence jurisdictions, GTBI (68.3%) took most calls from medium incidence jurisdictions, MCCT (70%) took most calls from low incidence jurisdictions, and SNTC calls were evenly split between high, medium and low incidence jurisdictions (Table 3).

CDC evaluation of RTMCC services [15] showed that satisfaction with RTMCC medical consultation services was high among end users from 47/60 (78%) programs that used the medical consultation service, with an average score of 4.7 on a scale of 1 to 5, with 1 being very dissatisfied and 5 being very satisfied. The lowest satisfaction score given by any program was 2.5 and the highest was 5 (Table 4).

Of 316 international consultations provided by the RTMCCs, the majority were from North America (44.9%) and Asia (38.0%), followed by Africa (8.9%), South America (6.3%) and Europe (1.9%) (Table 5). Most calls were from Mexico (36.7%), followed by Nepal (13.9%), Thailand (6.6%), Peru (6.0%), and Canada (5.0%) (Table 6). The

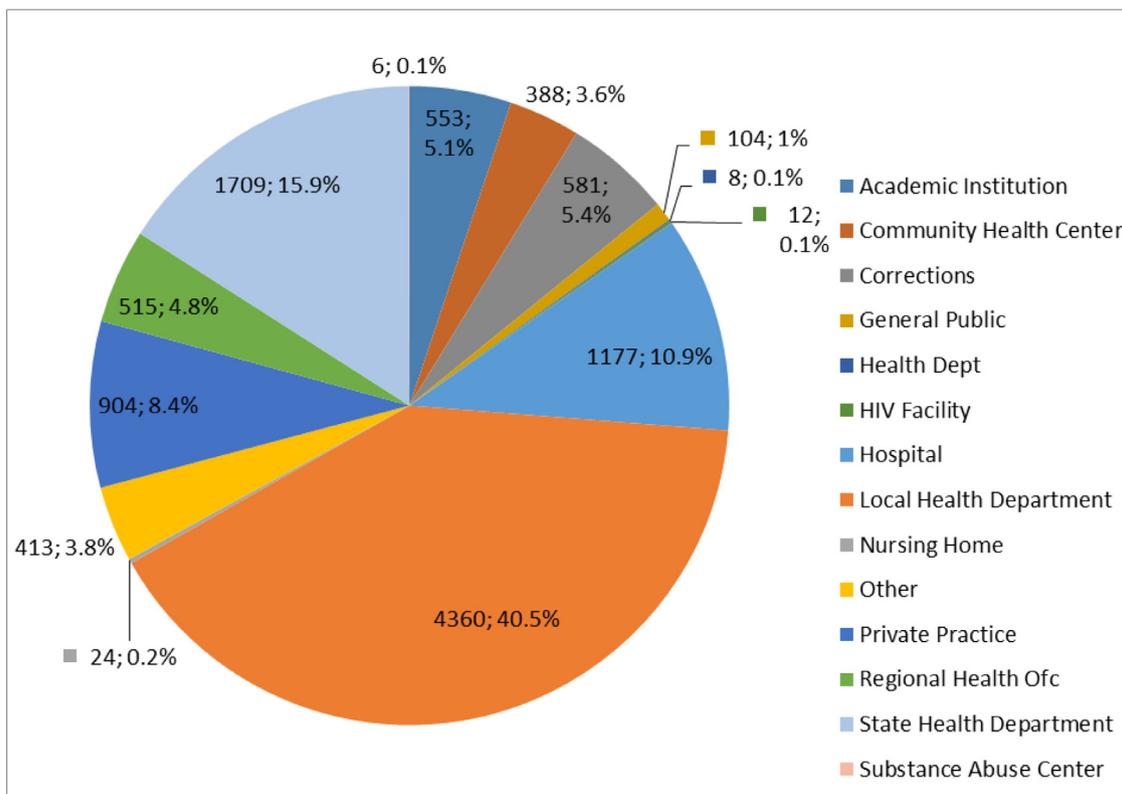


Fig. 5. Overall Occupational Settings of Callers
Occupational setting of health care professionals seeking consultation
Health Dept - unspecified.

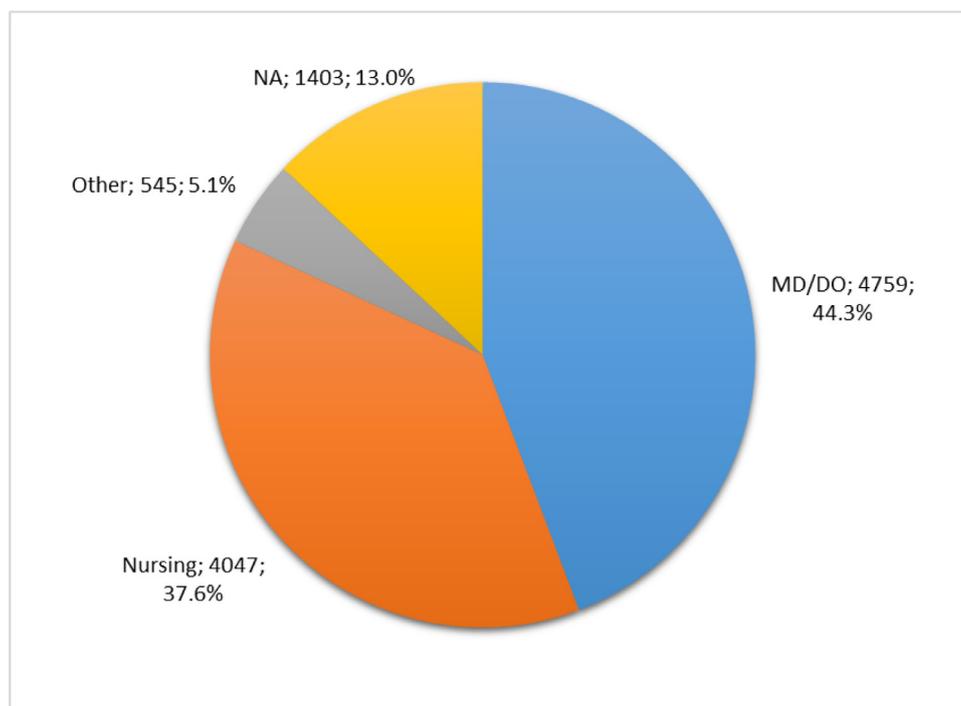


Fig. 6. Overall Work Discipline of Callers
Work discipline of health care professionals seeking consultation.

number of calls decreased over the study period from 97 to 67 per year. Of 314 patients who had age data collected, 83.2% of consultations were provided for adult patients. Overall, top call categories were, in descending order, TB disease (50.9%), case management (46.5%),

MDR/XDR (27.5%), diagnosis (25.0%), pharmacology (18.0%) and adverse side effects (13.0%) (Fig. 10), and, although there were slight differences, remained relatively consistent across continents. Similar to domestic consultations for adverse side effects, hepatotoxicity was the

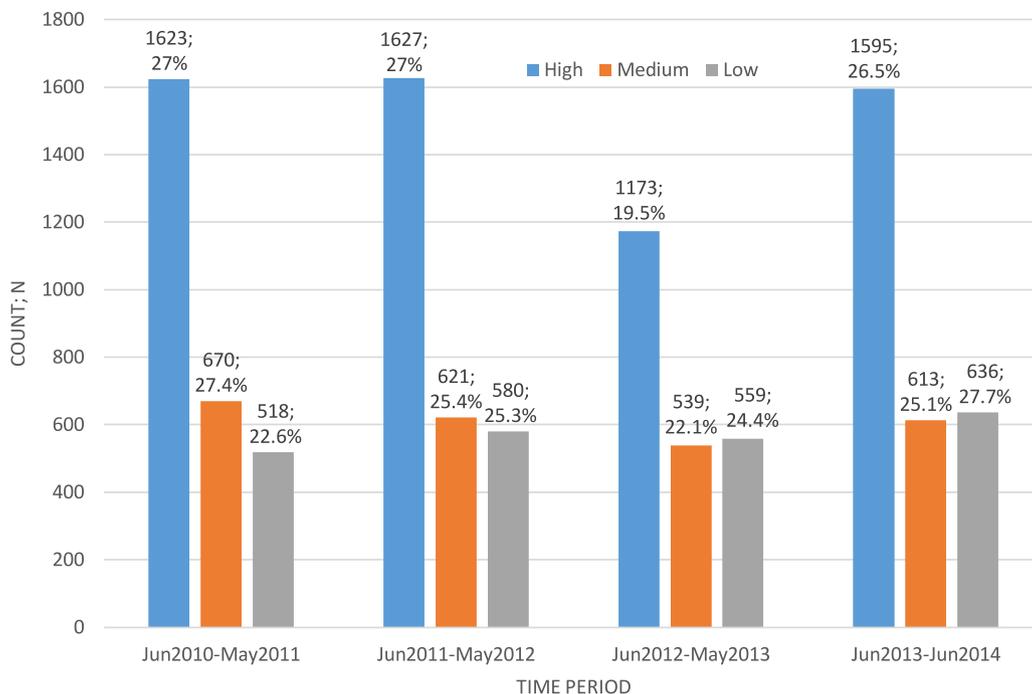


Fig. 7. Calls stratified by year of service and TB incidence of caller's jurisdiction
 Number of calls provided per year of service (June 1 – May 31) stratified by TB incidence of caller's jurisdiction (high > 800 cases per year, medium 100–800 cases per year, or low < 100 cases/year).

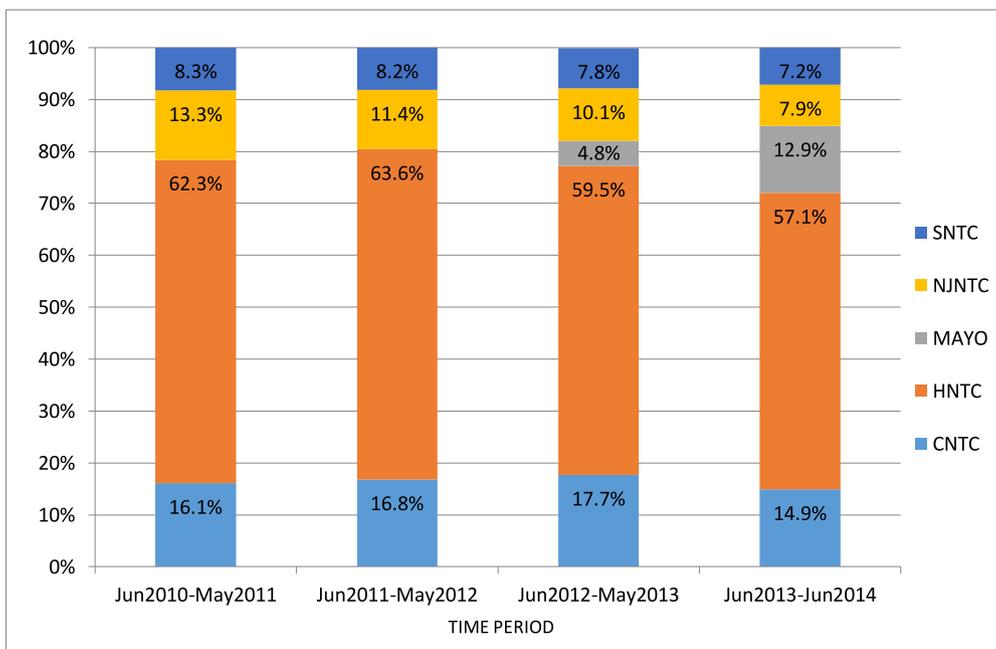


Fig. 8. RTMCC Calls stratified by year
 Consultations provided by each center stratified by center (MCCT was not funded until 2012)
 SNTC – Southeastern National TB Center; NJNTC – Global TB Institute; MCCT– Mayo Clinic Center for Tuberculosis; HNTC – Heartland National TB Center; CNTC – Curry International TB Center.

most common (22.7%) (Fig. 11). Callers were from government clinics/health departments (27.5%) and panel physicians (doctors screening immigrants and refugees before departure, including from the International Organization for Migration [IOM] sites screening refugees

[26.6%]), but a significant percentage were unidentified, i.e., in the “other” category (25.0%). Most calls were from physicians (77.5%) across all continents. Of 301 consultations that had turn-around-time collected, 81.7% were returned within 24 h (Fig. 12).

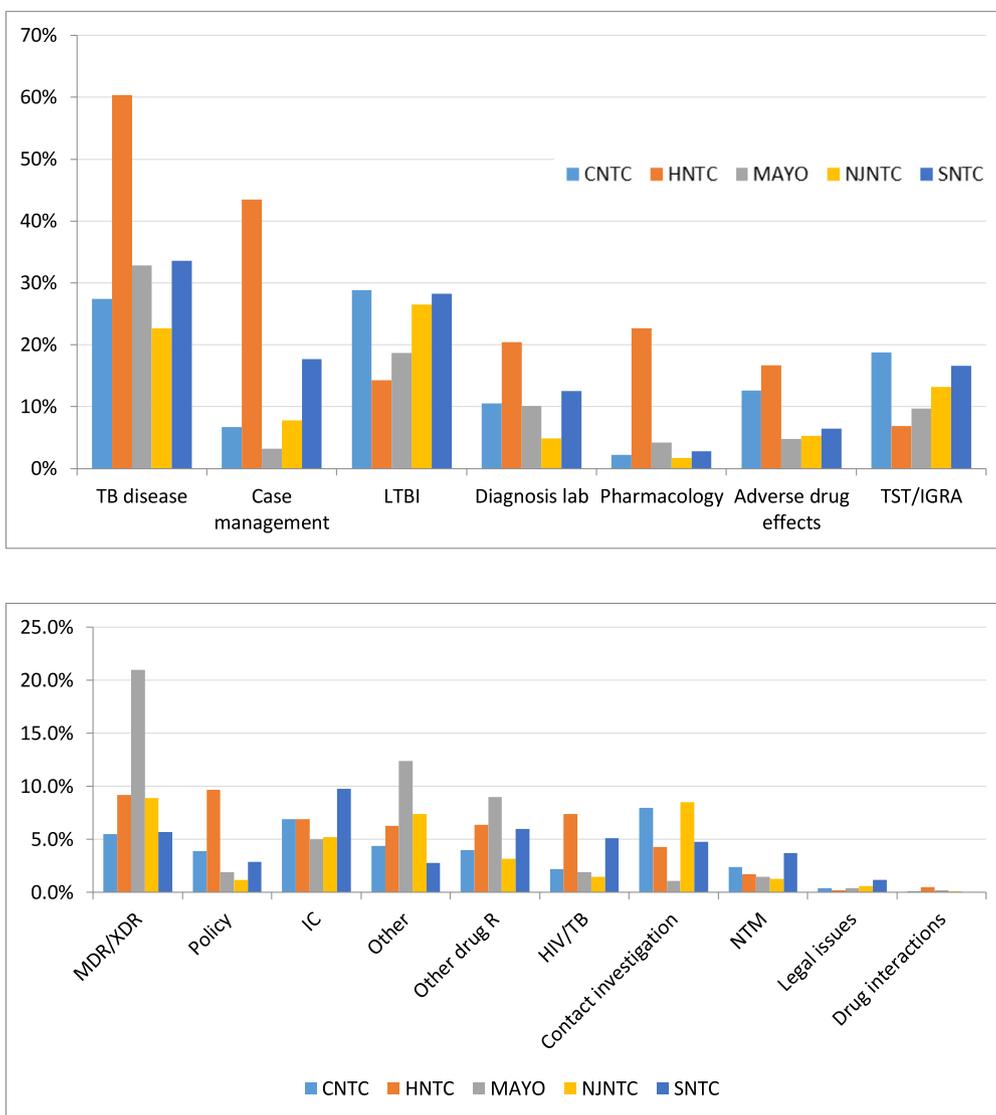


Fig. 9. Topic Areas stratified by RTMCC
 Consultation topic areas stratified by RTMCC
 SNTC – Southeastern National TB Center; NJNTC – Global TB Institute; MCCT – Mayo Clinic Center for Tuberculosis; HNTC – Heartland National TB Center; CNTC – Curry International TB Center.

4. Discussion

The World Health Organization (WHO) has recently adopted the End TB Strategy [16] which has set the ambitious goal of ending the global TB epidemic by 2030, with targets to reduce TB deaths by 95% and new cases by 80% and to ensure that no family is burdened with catastrophic expenses due to TB. TB is the leading infectious disease killer in the world and one of the top 10 causes of death worldwide [1]. There were an estimated 10 million cases of TB and 1.3 million deaths due to TB per the WHO Global Tuberculosis Report 2018 [17]. Only 9105 of these cases were reported in the United States in 2017 [18] therefore TB elimination (< 1 TB case/million population) is the national goal. Despite the low numbers of cases, the data presented suggest that the complexity of cases is high and access to expert consultation will remain a key component in the fight to end TB in the United States. As reported previously by Sumartojo et al. [8], there is an accompanying loss of medical proficiency in the diagnosis and treatment of people with TB as the disease becomes less common.

The CDC-funded RTMCCs successfully provided quality expert medical consultation to stakeholders (both in the public and private

sector) within the specified 24-hour turnaround-time for the care and management of TB patients in the United States. All centers had excellent turn-around-times for response and centers received positive feedback from end users through CDC evaluation of RTMCC services by TB programs.

As would be expected, the majority of consultations were provided for high incidence jurisdictions, but medium and low incidence jurisdictions also use RTMCCs, especially in the Pacific NE, Central MW, and the SE Regions of the country. The data of absolute numbers may be misleading as it does not represent the *per capita* rates of TB consultations. There were differences between high, medium and low incidence settings in the nature of medical consults, with more pediatric consultations and consultations for MDR-TB in the medium and low incidence jurisdictions. This may reflect less expertise in managing TB in special populations and drug-resistant disease in low TB incidence areas.

The topic areas were purposefully not mutually exclusive to enable the database to track every topic area that the consultation addressed. The topic “case management” was the second most common for both U.S. and international consultations; however, HNTC data skewed the

Table 3
RTMCC-provided consultations and TB incidence of caller's jurisdiction.

		Incidence			Total
		High	Medium	Low	
CNTC	Count	1047	132	575	1754
	% within RTMCC	59.7%	7.5%	32.8%	100.0%
	% within Incidence	17.4%	5.4%	25.1%	16.3%
HNTC	Count	4532	1148	846	6526
	% within RTMCC	69.4%	17.6%	13.0%	100.0%
	% within Incidence	75.3%	47.0%	36.9%	60.7%
MCCT	Count	0	143	333	476
	% within RTMCC	0.0%	30.0%	70.0%	100.0%
	% within Incidence	0.0%	5.9%	14.5%	4.4%
NJNTC	Count	110	785	254	1149
	% within RTMCC	9.6%	68.3%	22.1%	100.0%
	% within Incidence	1.8%	32.1%	11.1%	10.7%
SNTC	Count	329	235	285	849
	% within RTMCC	38.8%	27.7%	33.6%	100.0%
	% within Incidence	5.5%	9.6%	12.4%	7.9%
Total	Count	6018	2443	2293	10,754
	% within RTMCC	56.0%	22.7%	21.3%	100.0%
	% within Incidence	100.0%	100.0%	100.0%	100.0%

Consultations provided during the study period stratified by RTMCC and TB Incidence of caller's jurisdiction (high > 800 cases per year, medium 100–800 cases per year, or low < 100 cases/year).

Table 4
2016 Evaluation of RTMCC services: quantitative results for medical consultation (Scale: 1–5)*.

Question	Min	Mean	Max
Satisfaction with Medical Consultation Services Provided by the RTMCCs* (n = 47)	2.5	4.7	5.0

n = 47 U.S. TB programs.

* 1 = Very dissatisfied, 5 = Very satisfied.

Table 5
International calls by continent.

Continents	Frequency	Percent
Asia	120	38.0
Africa	28	8.9
North America except US	142	44.9
Europe	6	1.9
South America	20	6.3
Total	316	100.0

International consultations stratified by Region.

Table 6
International calls by country.

	Asia		Africa		North America		South America		Europe	
1	Nepal	44	Kenya	10	Mexico	116	Peru	19	France	1
2	Thailand	21	Ethiopia	5	Canada	16	El Salvador	1	Germany	1
3	India	12	Nigeria	3	Dominican Republic	4			Italy	1
4	Vietnam	10	South Africa	3	Haiti	4			Lithuania	1
5	China	8	Botswana	2	Cayman Islands	1			Switzerland	1
6	Philippines	7	Uganda	2	St. Lucia	1			UK	1
7	Malaysia	6	Egypt	1						
8	Japan	4	Malawi	1						
9	Jordan	2	Mozambique	1						
10	Bangladesh	1								
11	Cambodia	1								
12	Pakistan	1								
13	Saudi Arabia	1								
14	Singapore	1								
15	Turkey	1								
	Total 120	Total	28	Total	142	Total	20	Total	6	

International consultations provided stratified by country of caller.

results and this may represent a heavily nursing-based consultation method used by HNTC. This result underscores the added complexity of TB cases and the need for TB nursing consultation. The other most common topic areas across jurisdictions were treatment of TB disease and latent TB infection, diagnosis of TB, and drug dosage and management of drug related adverse effects. These findings show that clinicians tend to have many questions in the basic diagnosis, treatment and management of people with TB in the United States. Hepatotoxicity was the most common adverse side-effect of inquiry as hepatotoxicity can be a life-threatening condition. These findings suggest a training and education need for physicians and other health care workers in the identification and management of adverse side effects. In fact, regional and state differences in consultation topic requests have been used by the RTMCCs to design specific training and education objectives tailored for given geographical areas. This has been a very practical application and use of the data from the MCD. Physicians and nurses represent >80% of callers, but 18.1% of calls came from other health-care providers, suggesting that the centers should continue to provide training and education for allied health professionals. The majority of calls came from health departments, but hospitals, private providers, and academic institutions also accessed these services. It is possible that the centers could publicize access to their services to academic and private sectors. Additionally, the need for extended access to medical consultation services is suggested by a recent analysis of TB deaths in California, which identified multidrug resistance, care in private sector, and inadequate initial treatment regimen selection to be risk factors statistically associated with deaths [19].

Most callers requested consultation within 48 h, which reinforces the widely held viewpoint that there are few true TB related health emergencies. The turn-around-time for response was excellent, reflecting the dedication of the largely voluntary force of physicians and nurses who make up the expert consultant network of the RTMCCs. These consultants are generally academic physicians who have research, teaching and patient care responsibilities in addition to the voluntary service for the RTMCCs.

There was little variability in observations between the 4 study-years suggesting that the need for consultation, the types of patients and questions, and the services provided have remained stable over time. There were some differences between centers on topic areas for consultation largely driven by differences in TB incidence and the respective geographical region.

Although international consultations represented a small percentage of the whole, they tended to be complicated in topic, time differences requiring email consultation over days or weeks in many cases, language barriers, differences in diagnostic methods and treatment strategies, availability of state-of-the-art facilities, equipment and TB drugs,

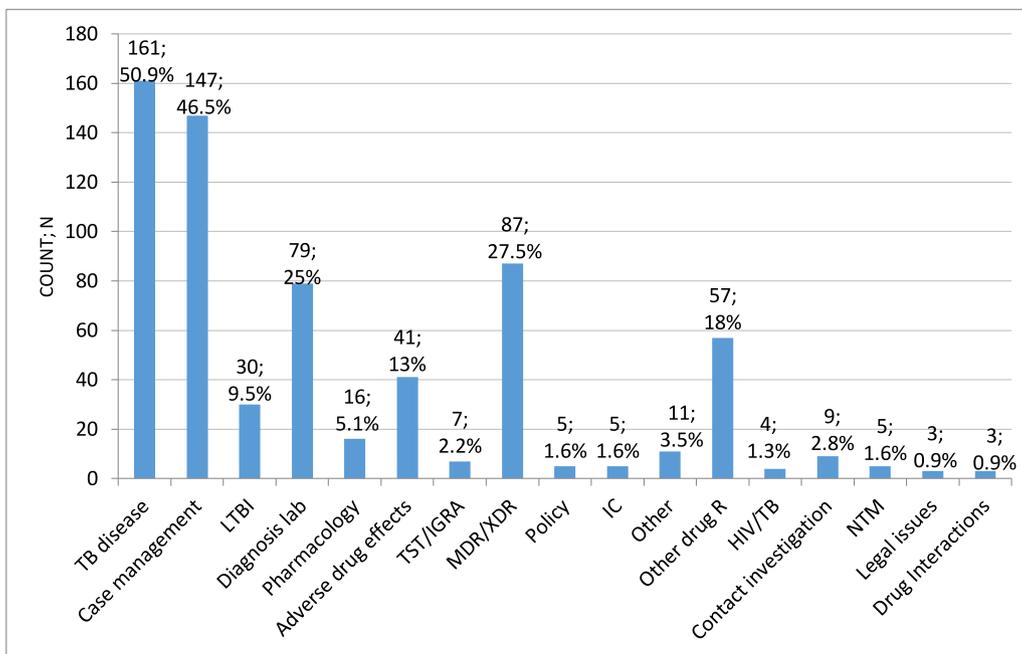


Fig. 10. International call categories (n = 314)
Topic areas for International consultations.

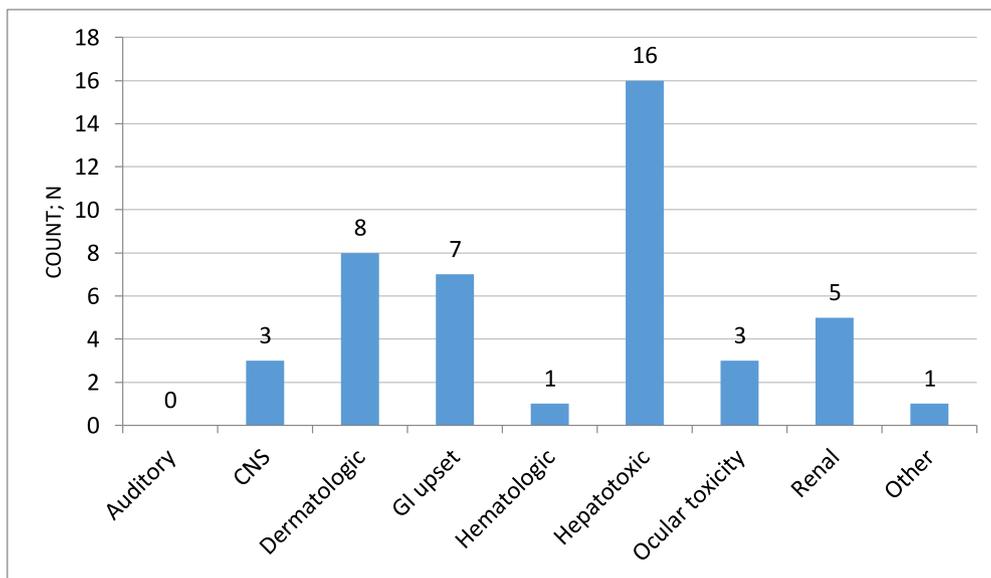


Fig. 11. International calls and adverse side effects (N = 44)
Adverse side effects reported among international consultations.

and complexity. The average number of communications per consult was two for international consultations (data not shown). This form of consultation was crucial, however, as new TBTIs for screening of overseas U.S. bound refugees and immigrants were adopted by CDC in 2009 and many new international screening sites were implemented and given intensive training and education on the new TBTIs between 2010 and 2013. The new TBTIs contributed to the decrease in U.S. TB cases and case rates over the subsequent decade [20,21], and the RTMCCs were instrumental in providing consultation for difficult and drug-resistant patients, providing training and education for panel sites, and for ensuring appropriate care and management overseas and decreased potential for transmission of drug-resistant TB in the United States, thereby contributing towards the goal of TB elimination.

A recently published study on MDR-TB outcomes in the United

States showed that, although the numbers of MDR/XDR-TB cases are low, diagnosis and treatment are very complex [22]. Medical consultation will be crucial in addressing the challenges that these and other complicated TB cases present. Recent studies show that the community-based treatment of MDR-TB leads to equivalent outcomes for patients and for communities [23]. RTMCCs will be integral in providing consultation during this transition to community-based care while still providing the option for hospitalization of extremely ill patients for optimal management.

Limitations of the study include non-standardization of medical consultation models between centers, which could lead to subtle differences in data not being captured, data not being representative of all TB cases in the United States since the denominator only includes patients who received RTMCC consultation, topic variables not being

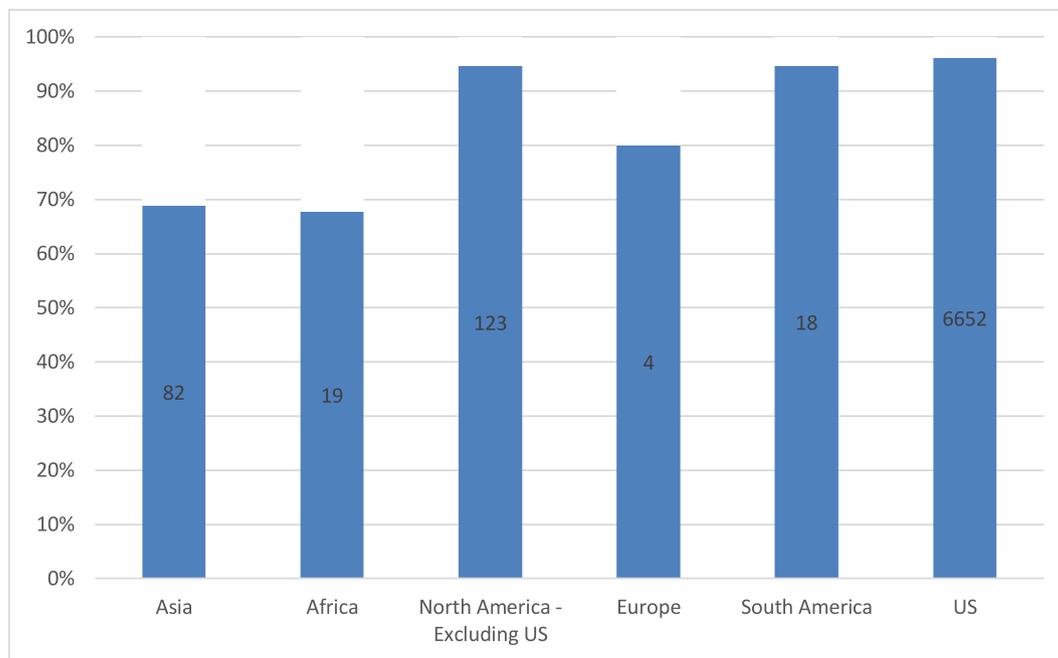


Fig. 12. Time to response from consultant within 24 h – international calls compared with domestic calls
Response provided within 24 h among international consultations stratified by Region.

mutually exclusive, and the occupational setting variable not being adequately defined (too many overlapping choices making interpretation of these data very difficult).

5. Conclusions

As the United States moves towards TB elimination, with diminishing case numbers and rates, and a corresponding decrease in institutional knowledge of TB, expert consultation for complicated and drug-resistant cases will gain increasing relevance and importance. As of 2018, the number of CDC-funded centers has been reduced to four, accompanied by change of nomenclature from RTMCCs to TB Centers of Excellence (COEs (see Annex 1)). These centers represent a crucial repository of subject-matter expertise in the United States, indispensable for achieving TB elimination in the context of limited resources and declining incidence. The centers must be able to provide consultation for a wide range of topics, from MDR/XDR-TB treatment to management of LTBI in an era of waning TB knowledge among healthcare practitioners and diminishing resources for public health. The centers may now be ready for a paradigm shift in consultation both towards ongoing continuity of care consultation for complicated TB cases to ensure treatment completion and cure and towards community-based care of MDR-TB.

Ethical statement

Ethical review by CDC was obtained for this evaluation, which was determined to be program evaluation activity, not human subjects research requiring institutional review board (IRB) approval. Ethical approval was similarly obtained from Mayo Clinic IRB as not human subjects research requiring IRB approval.

Conflicts of interest

None of the authors have any conflicts of interest.

Author contribution

All authors have contributed to the conception and design of the study, the acquisition of data, or analysis and interpretation of data, drafting the article or revising it critically for important intellectual content, and final approval of the version to be submitted.

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Annex 1 – Resources

HNTC - <https://www.heartlandntbc.org/>
 SNTC - <https://sntc.medicine.ufl.edu/home/index#/>
 GTBI - <http://globaltb.njms.rutgers.edu/>
 CITC - <https://www.currytbcenter.ucsf.edu/>
 All RTMCC resource page - https://www.cdc.gov/tb/education/tb_coe/default.htm

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