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Communicable disease surveillance and control in the context of conflict and mass displacement in Syria

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SUMMARY

Objectives: To describe trends in major communicable diseases in Syria during the ongoing conflict, and the challenges to communicable disease surveillance and control in the context of dynamic, large-scale population displacement, unplanned mass gatherings, and disruption to critical infrastructure.
Methods: A rapid review of the peer-reviewed and non-peer-reviewed literature from 2005 to 2015 was performed, augmented by secondary analysis of monitoring data from two disease early warning systems currently operational in Syria, focusing mainly on three diseases: tuberculosis (TB), measles, and polio.
Results: Trend data show discrepancies in case report numbers between government and non-government controlled areas, especially for TB, but interpretation is hampered by uncertainties over sentinel surveillance coverage and base population numbers. Communicable disease control has been undermined by a combination of governance fragmentation, direct and indirect damage to facilities and systems, and health worker flight.
Conclusions: Five years into the crisis, some progress has been made in disease surveillance, but governance and coordination problems, variable immunization coverage, and the dynamic and indiscriminate nature of the conflict continue to pose a serious threat to population health in Syria and surrounding countries. The risk of major cross-border communicable disease outbreaks is high, and challenges for health in a post-conflict Syria are formidable.

1. Introduction

The impact of conflict on communicable disease spread is well recognized, resulting from a combination of damage to critical infrastructure, including water and sanitation systems, reduced health system functionality, and – importantly – disruption to surveillance, outbreak response systems, and other disease control measures.[1,2] High profile outbreaks in Iraq and Syria in recent years have provided further evidence of this conflict-related public health threat in the Middle East, exposing the fragility of existing systems and the difficulties faced in maintaining and strengthening them.[3,4]

Guidance for health interventions in complex emergencies consistently highlights the need for simple but effective health intelligence systems covering mortality and morbidity data, laboratory services to support prompt diagnosis, and outbreak response planning, among other elements.[5–7] In disease surveillance

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terms, early warning systems – which rely on the identification of syndromes associated with diseases of public health importance (e.g. 'influenza-like illness') rather than formal laboratory diagnosis – are increasingly important in conflict-affected environments where passive, laboratory report-based systems may be impractical.[8,9] Early warning systems have significant advantages in timeliness of reporting, flexibility to incorporate new syndromes of concern, and low administrative and laboratory burden. However, there are equally well-recognized limitations, including low specificity and positive predictive value (especially for diseases with non-specific symptom profiles) and high false-alarm rates, which contribute to difficulties identifying true departures from statistical norms for outbreak detection purposes.[10]

The nature of the conflict in Syria poses particularly formidable challenges to the practical implementation of communicable disease surveillance and control for several reasons. First and foremost among these is the scale of population displacement that has occurred since the start of the conflict. Around 6.6 million Syrians have been internally displaced, many on multiple occasions,[11] with over four million refugees now outside the country.[12] The rapidity and regularity of these movements both within Syria and across its borders pose significant barriers to the effective and timely collection of data. On one hand, the crisis demands new strategies for 'undocumented' populations or those living in informal settings, who account for up to 80% of refugees now living in some neighbouring countries.[13] On the other, surveillance and control strategies must also apply to established and sizeable refugee populations in recognized camps, the existence of which predated the conflict (Yarmouk camp in Damascus, for example).

Second, the dynamics of the conflict in Syria – in particular the lack of regard for civilian safety, healthcare workers, and health facilities by warring parties – imposes major constraints on what is possible in surveillance and prevention. It is estimated that over seven million people within Syria are without access to basic healthcare,[14] and malnutrition – a major risk factor for the spread of communicable disease – is a worsening problem especially among besieged populations. Third, a lack of donor funding for the health response in general has hampered efforts by the World Health Organization (WHO) to establish and maintain effective monitoring systems throughout Syria. Finally, a combination of direct and indirect infrastructure damage, loss of trained personnel, and equipment shortages has undermined the capacity of what was a relatively well-functioning health system by middle-income country standards.[15,16]

The objectives of this paper are to examine the technical challenges to communicable disease prevention and control that have arisen in Syria and approaches implemented to date, with a view to providing realistic recommendations for improvement. The analysis was carried out in recognition of complex, ground-level realities featuring a combination of large-scale displacement and planned and unplanned mass gatherings in both formal and informal settings, and the immense personal safety risks to which many health workers in Syria are routinely exposed. The focus is placed on three exemplar diseases – measles, polio, and tuberculosis (TB) – with an emphasis on the situation inside Syria, although reference is also made to the situation in Turkey and Lebanon, countries that now host the largest numbers of Syrian refugees.

2. Methodology and conceptual framework

A rapid review of the peer-reviewed and non-peer-reviewed literature over a 10-year period between 2005 and 2015 was conducted to inform an assessment of communicable disease surveillance in Syria at 'baseline' (i.e., prior to the onset of the crisis). Non-peer-reviewed data included material from reports published by multilateral organizations including the WHO and the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), international donors, and non-governmental organizations with a significant field presence in Syria and surrounding countries. This was augmented by the analysis of data drawn from the two principal syndromic surveillance systems currently in operation in Syria: the Early Warning and Response System (EWARS) for Syria,[17] a system jointly administered by the WHO and the Syrian Ministry of Health, and the Early Warning and Response Network (EWARN),[18] administered by the Assistance Coordination Unit (ACU), which operates only in non-government controlled areas (NGCAs). The ACU was established in September 2012 by the Syrian National Coalition to coordinate increasing volumes of aid coming into NGCAs, provide some basic services, and support local committees involved in information and basic service provision on the ground; its activities now incorporate epidemiological surveillance. The analysis focused on case reporting for TB, measles, and acute flaccid paralysis (AFP), the clinical case description for suspected polio, and incorporated reports from week 1 in 2014 to week 48 in 2015 (the period for which weekly reports under both systems were available at the time of writing).

In assessing communicable disease surveillance and response capacities in Syria, guidance was taken from the framework for assessing capacity for implementation of the International Health Regulations (IHRs) on a national level, issued by the WHO in 2010.[19] This framework addresses governance and coordination, surveillance, outbreak preparedness and response, human resource development, and laboratory capacity, among other domains.

3. Results

3.1. Trends in major communicable disease groups in Syria, and issues in surveillance

Trend data from EWARN and EWARS over 2014 and 2015 (Figure 1) describe large variations in reports of suspected cases week by week in both systems, notwithstanding broadly similar case definitions for the three main diseases examined in this review (Table 1). Significant discrepancies by disease group are also visible; in particular, the reported case numbers for TB from EWARS are much greater than for EWARN. Upward trends in reports of severe acute respiratory illness (SARI – a general category including typical and atypical pneumonia, but excluding influenza-like illness) and acute bloody diarrhoea (ABD) are noted from EWARN data towards the end of 2015 and are suggestive of large outbreaks distinct from those reported earlier in the conflict.[20] Trends for measles case reporting through EWARN and EWARS appear better matched, albeit from a proportionately lower number of consults and sentinel sites for EWARN (Figure 2). Trends for AFP are not given in Figure 1 because case report numbers were low throughout the period; there were an average of 3.3 and 2.4 cases per week under EWARN and EWARS, respectively.

Detailed interpretation of these patterns is difficult for several reasons. First, variations in total numbers of consultations (trends for which were particularly erratic for EWARS at the beginning of the period) and sentinel site coverage both over time and between the two systems may partially explain observed trends. Sentinel site numbers for EWARS and EWARN rose by 120% and 260%, respectively, over the period, with broadly comparable median reporting rates at 83% and 86%, respectively. However, these factors are unlikely to account for relatively stable total consultation numbers reported through EWARS compared with a dramatic

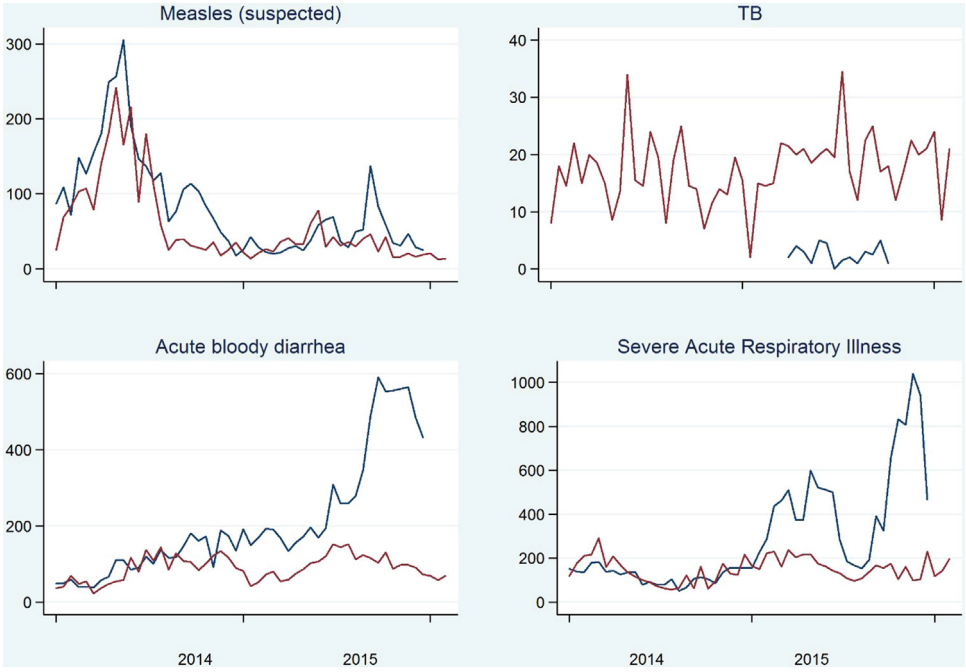

Figure 1. Trends in reported cases of major disease groups in Syria from the World Health Organization Early Warning and Response System (WHO EWARS; red) and the Assistance Coordination Unit Early Warning and Response Network (ACU EWARN; blue) in 2014 and 2015.

rise through EWARN. Second, building a robust picture of disease dynamics across Syria is complicated by continuing uncertainty over the geographical coverage of the two surveillance systems, the fluidity of developments on the ground, and the immense safety risks involved for those engaged in data gathering.[21] Both EWARS and EWARN now produce weekly reports, and increased sentinel site coverage offers a more complete picture of case reporting for communicable disease than at any stage in the

Table 1
Surveillance case definitions and alert and outbreak thresholds used by EWARS and EWARN for acute flaccid paralysis, suspected measles, and tuberculosis

Disease/condition	Case definitions		Alert threshold		Outbreak threshold	
	WHO EWARS	ACU EWARN	WHO EWARS	ACU EWARN	WHO EWARS	ACU EWARN
Suspected measles	Any person with fever AND maculopapular generalized rash AND one of the following: cough, coryza, or conjunctivitis OR any person in whom a clinician suspects measles infection (definition now common to both systems)		1 suspected case	1 suspected case	Cluster of ≥3 clinical cases in a single location over a 30-day time period with at least 1 laboratory-confirmed case	Occurrence of ≥4 reported clinical cases of measles in a health facility OR in a given geographical area within 1 week
Acute flaccid paralysis (AFP)	Any child under 15 years of age with AFP OR any person of any age with paralytic illness if poliomyelitis is suspected (except for traumatic paralysis) (definition common to both systems)		1 suspected case	1 suspected case	1 confirmed case (including laboratory confirmation) of poliomyelitis (definition common to both systems)	
Tuberculosis (TB)	TB is not on the core surveillance list at present. Confirmed cases in line with the National TB Programme case definition are included, i.e., a constant cough for ≥3 weeks, or cough with bloody sputum, without improvement with specified treatment, or the presence of the following symptoms: fatigue, loss of appetite, weight loss, night sweats, fever, shortness of breath, chest pain	TB is not on the core surveillance list at present. Only information on confirmed TB diagnoses is currently gathered through EWARN, under the category 'other'	≥5 cases of pulmonary TB at a particular location or in areas that are not affected OR duplication of weekly average reported cases of pulmonary TB in the last 3 weeks at a particular location in endemic areas	Not applicable	Not applicable	

EWARS, Early Warning and Response System; EWARN, Early Warning and Response Network; WHO, World Health Organization; ACU, Assistance Coordination Unit.

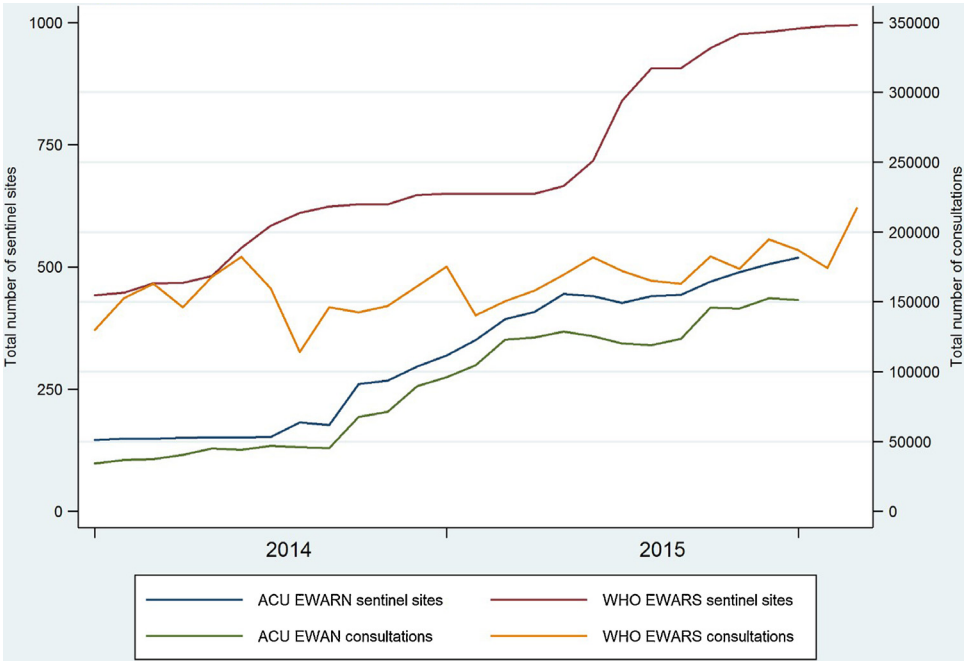

Figure 2. Total numbers of consultations by week, and number of reporting sentinel sites for EWARS and EWARN, 2014–15.

preceding 5 years.[22] However, changes in base population numbers due to displacement, or as territory has changed hands, make detailed analysis of disease burden impossible.

To some extent, trend shape and evolving sentinel site coverage nationwide reflect major difficulties with surveillance, especially in the early years of the conflict. Although a core communicable disease surveillance system was in place in Syria before 2011 with some moves towards computerization,[23] it was under-developed. Active surveillance for polio (as AFP) and measles occurred primarily through primary healthcare unit case-reporting.[24] Prior to the conflict, Syria also had an active TB control programme, which oversaw a reduction in TB prevalence from 85 per 100 000 in 1990 to 23 per 100 000 in 2011,[25] but low case detection was a significant problem.[26]

In the first year of the conflict, systematic surveillance broke down and it was not until 18 months after the beginning of the crisis that this deficit began to be addressed. The WHO launched EWARS in September 2012, but the precise geographical coverage of this system was and remains unclear – with a focus on government controlled areas (GCAs).[27] The coverage of EWARS is steadily improving, although some degree of double-counting with EWARN is likely.[28] NGCAs of the country are, for the most part, covered by EWARN, which was established in June 2013 with support from the Centers for Disease Control and Prevention (CDC).[29] EWARN gathers some data on areas of the country under the control of Daesh (the so-called 'Islamic State'), from which very few reliable data are otherwise publicly available.

For TB, disruption of all aspects of the control programme, including prevention, case finding, diagnosis, and management, has led to an increase in cases amongst displaced populations. In 2014, the WHO recorded a TB rate of 19 per 100 000 and 3481 cases were notified, with an estimated 6.2% of new cases and 31% of retreatment cases having multidrug-resistant TB (MDR-TB). The current prevalence of TB – in both fully sensitive and MDR-TB forms – is unknown due in part to the disrupted nature of the infrastructure with limited facilities to diagnose and treat TB, particularly in NGCAs; this may account for the fewer cases recorded by EWARN, although under-reporting is possible. Over-crowding, poor sanitation, and malnutrition amongst displaced populations all encourage the spread of TB in this population. The lack of information on the health status of prisoners in Syria – of whom there are now large numbers on both sides – is a particular concern in the context of TB, given what is known about the spread of infection in incarcerated populations.[30] Although the International Committee of the Red Cross have been able to visit some detention facilities, access to detainees nationwide remains poor.

At the regional level, the WHO led the creation of a network of early warning systems across Syria and key surrounding countries in late 2014, to improve the cross-border monitoring of disease. However, issues of harmonization remain – not least because systems in these countries use different week dates for reporting, and Turkish sites are not included.[31]

3.2. Challenges to effective communicable disease prevention and control: the broader view

The effectiveness of surveillance systems is one of many barriers to communicable disease control in Syria. Other challenges to communicable disease control that have arisen in the Syrian crisis are outlined in the sections that follow.

3.2.1. Laboratory and human resource capacity

Communicable disease surveillance is primarily case report-based, a blunt tracking approach, especially for polio where clinical illness (AFP) is documented in only a minority of infected individuals and for which guidelines require laboratory confirmation.[32] The practical difficulties of laboratory case-confirmation in the context of a dynamic conflict are, however, considerable. Recommended approaches to suspected polio cases provide a clear example: stool samples gathered in GCAs are tested in laboratories in Damascus but must still be transported across the country with the attendant risks to health workers involved;[21] those gathered in NGCAs must be transported abroad, commonly to Turkey, where processing and the delivery of results are often delayed.[32] The most recent data available – from the third quarter of 2015 – suggest that of those public health facilities still functional in Syria, 44%

had access to basic laboratory facilities,[33] but few of these will have the capacity to perform the specialized tests required to confirm communicable disease cases. Understanding of the situation in health facilities in NGCAs – where no comparable surveys have yet been carried out – is limited. Furthermore, shortages of trained health workers in some parts of the country are now acute. Although robust data on the extent of worker flight are not available, remaining laboratory staff are overwhelmingly concentrated in GCAs – particularly Damascus and Tartous.[33]

Similarly, for TB, the nature and dynamics of the conflict in Syria pose major challenges to delivery of 'best' care, including laboratory confirmation. It is estimated that in some areas, including Aleppo, more than two-thirds of health facilities are no longer functioning.[34] Even where facilities exist, diagnostics, particularly microbiological ones, are rarely available. In NGCAs, for instance, there are no laboratories capable of mycobacterial culture; at most, facilities are able to offer sputum smear testing for the acid-fast bacilli of TB but not culture, therefore reported cases are likely the tip of the iceberg. In this context, innovative approaches are required to ensure that early case detection, treatment initiation, contact tracing, and follow-up is implemented to reduce the risk of treatment interruption and subsequent drug resistance. Promising models involving altered clinical suspicion thresholds for TB using alternative markers of infection (as now used in the Jordanian National TB Programme (NTP), and discussed in more depth below) may offer practical ways forward in addressing diagnostic challenges inside Syria.[25]

3.2.2. Outbreak preparedness and response

Outbreak preparedness and response in Syria has, in the main, been handled in a post-hoc fashion since the conflict began – as exemplified by the polio outbreak in 2013–14. Prior to the outbreak, no cases of indigenous polio had been recorded in Syria since 1995, and the last laboratory-confirmed case was in 1999. In 2013, the WHO announced that it had detected a 'hot cluster' of cases in Deir Ezzor, with wild poliovirus type 1 found in two of 18 cases of reported AFP.[35] Subsequently, 25 cases were reported in Deir Ezzor, five in Aleppo, three in Idlib, two in Al-Hasakeh, and one in Hama between October 2013 and January 2014.[36] Subsequent testing confirmed that a polio case in Iraq could be traced to the original strain in Syria, and a Public Health Emergency of International Concern (PHEIC) was declared,[37] bringing in agencies such as WHO, UNICEF, and the Global Polio Eradication Initiative.[38]

Formal recognition of the outbreak prompted a multi-country regional response, with a variety of actors involved in immunization day campaigns in order to contain the outbreak, and 16 country-wide and localized campaigns in Syria.[36] Reported oral polio vaccine (OPV3) coverage nationwide had been greater than 95% among those aged under 1 year in Syria between 2002 and 2010, but had fallen to 52% among those aged 12–23 months in the period preceding the outbreak,[39] although these figures are now contested.[21] In any event, it is clear that coverage, especially in opposition areas, was already far below minimum standards.[27] It was therefore particularly important that negotiations occur at the start of the outbreak to ensure that the delivery of bivalent oral polio vaccine was agreed across all opposition-held areas.[21] A vaccination drive was conducted in seven governorates outside government control (Aleppo, Idlib, Latakia, Hama, Al-Raqqah, Alhasakeh, and Deir Ezzor), led by eight Syrian and regional NGOs with support from the ACU (the Polio Control Task Force). Although a WHO and UNICEF-led strategic plan to govern polio outbreaks was produced for Syria and surrounding countries, this was not published until late November 2013, some weeks after the outbreak had been officially announced.[40] Transmission was finally halted after a series of mass vaccination campaigns held across the country reaching more than 2.9 million children under 5 years of age with repeat doses of oral polio vaccine.[36] Syria is now approaching 2 years without a reported case of polio, but it will be another year before polio can be declared completely eradicated.[35]

3.2.3. Health governance disruption and coordination challenges

Many of the challenges described above are related to broader health governance fragmentation as the conflict enters its sixth year. Within Syria, health system oversight has largely been outsourced to the WHO (GCAs) and ACU (NGCAs), but at least three health systems now operate in parallel, including government, opposition (Nusra, Free Syrian Army), Daesh, and semi-autonomous Kurdish areas. The 'Whole of Syria' approach, adopted in September 2014 to better coordinate health activities by over 100 health responders in three hubs (Damascus, Amman, and Gaziantep), has only been partially effective due to difficulties coordinating the response across such a broad range of actors.[22]

3.2.4. Immunization and communicable disease prevention

Routine data collected by the WHO, UNICEF, and the World Bank demonstrate a significant decline in routine vaccination coverage since the onset of the conflict in Syria in 2011, but also suggest that official statistics consistently overestimated the extent of coverage in the years leading up to the conflict, and since 2011 (Figures 3 and 4). Having had above 95% coverage of oral polio vaccination from 1996 until 2011 according to official statistics (but 83% coverage according to WHO/UNICEF data), coverage subsequently dropped to between 68% and 80% between 2011 and 2014 (52–75% according to WHO/UNICEF statistics).[41] Likewise vaccination with the measles-containing vaccine dropped for MCV1 and MCV2 from 99% coverage (82% according to WHO/UNICEF) in 2010 to 71% and 66% coverage, respectively, in 2014 (54% and 49% from WHO/UNICEF figures).[41] World Bank figures show that the percentage of children aged 12–23 months vaccinated for measles in Syria between 2011 and 2014 dropped from 80% to 54%.[42] Mass displacements and crowded conditions have both led to increased outbreaks of measles, a principal cause of child mortality in humanitarian emergencies.[43] Fifty new cases of suspected measles were reported over 27 weeks in 2014,[44] and there were 10 000 cases of measles reported in Syria and Turkey in 2014.[35] WHO, UNICEF, and partners organized five immunization campaigns in Syria between March 2011 and the end of 2012,[21] but the coverage varied depending on location and the security situation.[36]

Adverse events, though rare, have contributed to problems with vaccine delivery. In some parts of Syria there was increased suspicion of vaccination campaigns after atracurium – an intravenously-administered skeletal muscle relaxant – was found to have been incorrectly used as a diluent for a measles/rubella vaccination campaign in rural northern Syria in 2014, resulting in the deaths of 15 children.[45] This demonstrates the additional difficulties in providing training and support to healthcare workers working in areas of conflict and instability.

3.2.5. Challenges for communicable disease case management in healthcare settings

Challenges to clinical case management for communicable disease in Syria are well illustrated by the case of TB. Prior to the conflict, directly observed treatment (DOT) was administered by the Ministry of Health either in primary health clinics or through outreach initiatives in Syria. Since the beginning of the conflict, the destruction of healthcare facilities, health worker flight, and difficulties with follow-up and contact tracing have made service delivery very challenging in NGCAs; interrupted drug supplies and the estimated tens of thousands imprisoned increase the likelihood of drug-resistant strains of

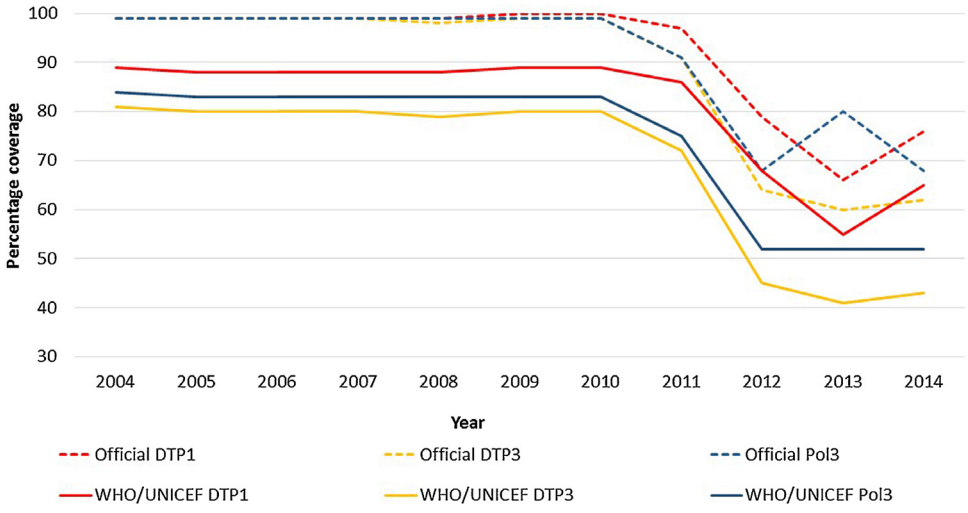

Figure 3. Trends in vaccination coverage for polio (in DTP1, DTP3, and Pol3 administration) for Syria, 2004–14. .

TB emerging. The situation is different in GCAs where it is likely that the NTP is still operative; however, the referral of suspected cases from NGCAs may endanger the lives of patients or their families. The increase in TB cases in countries surrounding Syria, particularly Lebanon and Jordan, has been attributed to Syrian refugees,[25] with Lebanon reporting a 27% increased incidence. In collaboration with the International Organization for Migration, the United Nations High Commissioner for Refugees (UNHCR), and the CDC, the Jordanian NTP developed a public health strategy for TB amongst Syrian refugees to increase case detection. This included ensuring adequate access to refugees, available human resources, quality assured diagnostic laboratory facilities, drug procurement, capacity to deliver DOT, and follow-up for cases.[25] Given low smear-positive rates, amongst other reasons, the NTP altered the clinical suspicion threshold to include suspected cases who are smear-negative but have had a cough for more than 3 weeks, have not responded to non-TB antibiotics, and have chest radiograph changes consistent with TB.[25]

4. Discussion

Despite improvements in communicable disease surveillance system coverage in Syria in recent months, major challenges to effective monitoring, prevention, and control remain. The dynamic nature of the fighting, the scale and rapidity of population movements, the extent of degradation to healthcare facilities and other core infrastructure, and threats to the safety of health workers, all impose significant constraints on the effectiveness of communicable disease surveillance and control. As the evidence reviewed above demonstrates, epidemiological trends for key communicable diseases remain difficult to describe from an intervention-targeting perspective. Furthermore, there are some diseases – including HIV/AIDS – for which very few data are currently available from Syria, despite cross-regional evidence that rates may be rising faster in the Middle East and North Africa than anywhere else in the world (albeit from a comparatively low level) and evidence of rising prevalence among certain risk-groups.[46,47] In a practical sense, assessment of the strength of communicable

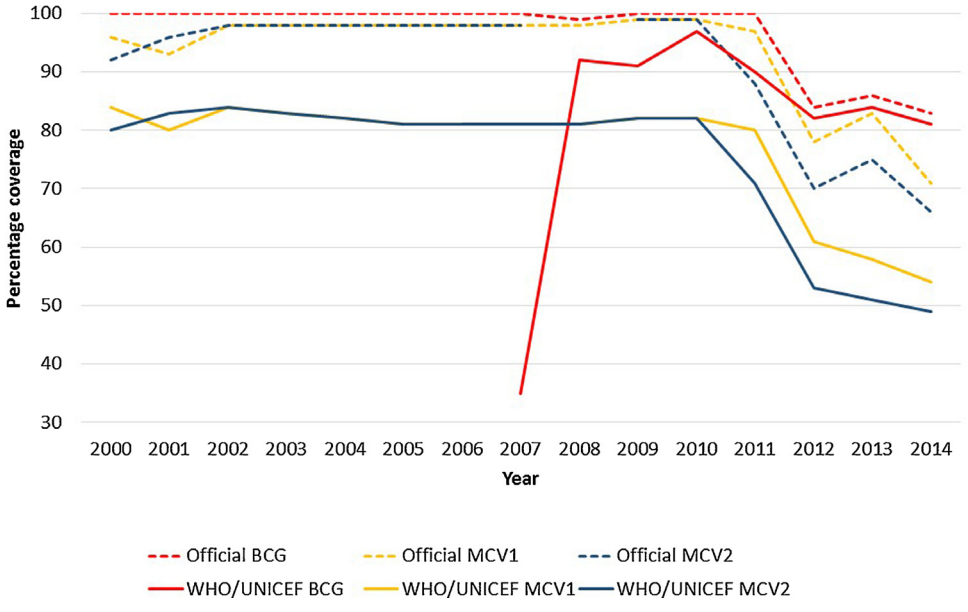

Figure 4. Trends in BCG and MCV1 and 2 coverage for TB (red lines) and measles (yellow and blue lines), respectively, 2004–14.

disease surveillance, preparedness, and response systems in Syria using existing frameworks (e.g., the IHRs) is challenging. The IHRs emphasize central capacity-building and institutional oversight in a way that may no longer be practical in Syria, both because government legitimacy is essentially contested and because governance structures are fragmented.

Recommendations for strengthening communicable disease control in Syria must begin with improved coordination between surveillance systems. There is a need to strengthen coordination of disease surveillance not just inside Syria but across the region. In addition to the regional system implemented by the WHO in collaboration with neighbouring governments described above, there are moves towards regional data integration through a community-level assessment programme (ECAP) and health surveillance programme being piloted by Médecins Sans Frontières in Iraq and extended to Lebanon and Jordan in 2016 (personal communication, Médecins Sans Frontières).

Within Syria there is a continuing need to ensure that both EWARN and EWARS (1) use consistent case, alert, and outbreak threshold definitions, and (2) publish clear (and ideally geographical information system-linked) information on the extent of their geographical coverage, with a view to the creation of a single, robust data repository that allows for queries across geographic area and time. With respect to improved case identification, the development of basic or mobile laboratory capacity that is clearly tied to EWARN and EWARS case-reporting would improve the promptness of diagnosis. Alternatively, clearer clinical guidance based on parsimonious case definitions and increased use of presumptive treatment may be needed.

The breakdown of basic health systems and primary healthcare, mobile populations, and security issues in reaching some of the most vulnerable populations in Syria mean that vaccination remains a challenge. However, the success of the Polio Task Force in accessing populations across territory controlled by a number of actors, including Daesh, illustrates that vaccination coverage can be improved rapidly if existing networks are capitalized on and local agreements brokered. Ongoing work to improve vaccine technology to increase ease of administration, including having fewer doses and being more thermostable, may over the long term make substantial contributions to prevention and control in conflict settings.[44]

From a case management perspective, evidence on TB suggests that simpler case definitions could be used in NGCAs inside Syria to allow treatment on suspicion of TB given the lack of available diagnostics. However, in these populations, with high proportions displaced, some more than once, management with appropriate compliance monitoring and follow-up is challenging. Patient-held records, whether in paper or electronic format, could be an appropriate measure to ensure continuity. DOT is challenging in this context with ongoing conflict, displacement, overwhelmed health facilities, and road blocks in place; innovative measures may include video-observed therapy (VOT), particularly in relatively stable areas, which has been tested in middle-income settings elsewhere.[48] More broadly, antimicrobial stewardship and infection prevention and control measures are important in containing what could become an increasingly important public health issue both within Syria and in neighbouring countries and increasingly challenging to contain.

Although beyond the scope of this paper, data on the extent to which antimicrobial resistance affects case management in Syria and surrounding countries, especially for bone and soft tissue injuries, provide an important barometer of laboratory functionality.[49] Health infrastructure damage, the exodus of trained healthcare workers, and poor sanitation, alongside poor antiseptic technique, antibiotic stewardship, and health facility crowding provide fertile ground for resistance to develop. Little is known about antimicrobial resistance in Syria pre-conflict; however the overuse of antibiotics, their availability without prescription, and interrupted treatment courses due to inadequate supply or inability of patients to pay for a full course, may all contribute to resistance in this setting. In most healthcare facilities, microbiology diagnostics are not available or quality-assured. Although there are few recent reports, a study from Aleppo in 2014 reported rates of multidrug-resistant Pseudomonas of 54%.[50] Reports from neighbouring countries state multidrug-resistant bacteria isolated from Syrian patients of up to 69%,[51] although this may not be representative of the situation inside Syria. Support and capacity building to the few remaining microbiology facilities in NGCAs could support the early detection of resistant bacteria, amongst other pathogens.

This article concludes with two broader observations. First, coordinated action now to develop surveillance and control systems offers an opportunity to set in place foundations for nationwide governance systems and the backbone for a post-conflict health system for Syria. Negotiations over the creation of these systems could provide neutral spaces for agreement of common principles between warring parties; interruption of polio transmission and even efforts towards eradication have been possible in other conflict settings through community involvement and negotiation of ceasefires or truces.[52] Second, failure to address communicable disease surveillance and control shortfalls in Syria presents major challenges to surrounding countries. This is demonstrated both by evidence on TB as cited above and by the well-recognized rises in caseload of cutaneous leishmaniasis among Syrian refugees in Lebanon (particularly *Leishmania tropica*, which requires prolonged, sometimes parenteral therapy) and Iraq[53]; this has prompted pesticide spraying campaigns, enhanced surveillance, and the distribution of free medication by the Lebanese government.[54] Real-time tracking of cases, education of health workers, improved availability of diagnostics for challenging cases, and availability of appropriate treatment early in the outbreak in Syria would have helped avert this situation.[55] Robust and coordinated action is needed now to meet the challenge from diseases like TB, which typically have few clinical signs in the early stages of infection.

Conflict of interest: No conflict of interest to declare.

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