Health Sector Shortcomings Associated with Measles Outbreaks in Cape Town, South Africa¹

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Abstract – Measles is viewed mainly as a public health concern constituting an object of study through epidemiological methods. However, the complexity of the risk factors that drive measles outbreaks suggests the need for wider and more inclusive conceptualisation beyond conventional biomedical methods. This prompted the application of a more integrative research approach to measles outbreaks in Cape Town. The study employed a mixed-methods approach, including an epidemiological analysis of measles cases to identify and characterise measles outbreaks. Qualitative methods were used to identify and differentiate key health sector shortcomings as well as risk governance deficit areas associated with the progression of measles risk. Results underlined the value of applying an integrated epidemiological and risk governance framework. They included multi-scalar institutional shortcomings that revealed systemic issues in the management of measles outbreaks. These were wide-ranging, and indicated system-wide issues related to monitoring and early detection, reflected at national, provincial and health worker levels. The research identified recurrent shortcomings at provincial level. These included a focus/ investment on mass rather than routine vaccination; as well as, poor mass immunisation planning due to systemic under-estimation of the exposed population (due to use of live births statistics and exclusion of in-migration data, which artificially inflated vaccination coverage). A further limitation was indicated by difficulties in involving key stakeholders in Outbreak Response Immunisation (ORI) and Supplementary Immunisation Activities (SIAs) (especially the Education Department). At health worker level, poor completion of case investigation forms was a recurrent deficit, constraining accurate characterisation of specific outbreaks. An emergent shortcoming following the 2009-2011 outbreak was the failure/ delayed diagnosis of the index measles case, which critically delayed intervention, limiting effectiveness of ORI. These findings underline the value of applying an integrative risk lens to the understanding of epidemic risk in urban settings with high levels of population mobility/migration, where public health services face multiple pressures.

Keywords – Risk Governance, Outbreak Risk, Disaster Risk, Vaccine, Measles, Re-Emerging Infectious Diseases, Cape Town

1. Introduction

There is growing awareness that sustainable development advances when risks are anticipated and systematically reduced (UNISDR, 2013). This is especially evident in approaches to managing disaster risks, where rising global interconnectiveness has increased the prospects for shocks to concatenate across geographic and administrative boundaries (Biggs, 2011). However, while integrated strategies to reduce disaster risks have proved valuable in averting losses from recognisable physical threats (such as earthquakes and floods), such approaches have been

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seldom applied to the management of communicable disease outbreaks. This is particularly relevant in the case of southern Africa where, since 2000, transboundary communicable disease outbreaks such as cholera and measles have constituted the leading cause of disaster-related mortality (Holloway et al., 2013).

This paper explores the applicability of a more integrative disaster risk analytic perspective to the management of recurrent communicable disease outbreak risks through the lens of a decade of measles outbreaks in the City of Cape Town (CoCT), South Africa. It begins by introducing current thinking on disaster risk and risk governance, followed by a focus on measles and prevailing approaches to reduce measles outbreak risks. It continues by characterising three successive measles outbreaks in the City of Cape Town, augmenting epidemiological findings with insights derived from a risk governance deficits analysis and concludes by discussing these results.

2. Disaster Risk as a Framing Perspective

In recent years, there has been growing awareness of the need to reduce risks developmentally, in a move beyond reactive and often costly, emergency interventions (UNISDR, 2013). This focus on disaster risk reduction, recognises that losses attributed to naturally occurring threats, such as weather systems and earth instability, are substantially influenced by environmental, socioeconomic and political conditions (Figure 1) (UNISDR 2004). These overarching risk drivers influence exposure to external threats (or hazards) as well as vulnerability to adverse effects, including property damage, displacement, illness and death.

Increasing attention to disaster risk reduction is also signalled by new risk terminology, including for instance, ‘disaster risk management’, (Mechler, 2004) ‘disaster risk analysis’ (Köhler, 2008) and ‘disaster risk science’ (Holloway, 2005 and Holloway, 2009). The recently emerged concept of ‘risk governance’ is particularly relevant to the management of communicable disease outbreak risk. Elaborated by both Renn (2008) and the International Risk Governance Council (IRGC, 2010), risk governance is an inclusive concept, referring to the structures and processes that identify, assess, manage and communicate multifaceted risk processes across multiple actors (Renn, 2008; IRGC, 2010). Consistent with the argument that heightened internal vulnerability increases the likelihood of adverse effects under threatening conditions, ‘risk governance deficits’ compromise the effectiveness of social systems and institutions (IRGC, ibid). Specifically, these constitute deficiencies or failures in the identification, assessment, management or communication of risks, which constrain the effectiveness of the risk governance process (ibid).

The broader disaster risk and associated risk governance themes are directly applicable to the management of measles outbreak risk, recognising that outbreaks are influenced by population determinants of disease (Bhopal, 2002). The Disaster Risk Reduction (DRR) Framework represented in Figure 1 traces the progression of risk over time, person and place (UNISDR, 2004). It illustrates the general progression of vulnerability and exposure to hazards towards a possible or realised disaster impact. While initially conceptualised in relation to disasters triggered by natural hazards, this broader, more integrated approach to risk progression is also relevant for strengthening outbreak risk management. Yet, contemporary approaches to the management of measles outbreaks have been confined more narrowly to early warning, preparedness, emergency management and recovery, as illustrated in the darkly shaded area in the lower left hand corner of Figure 1 (UNISDR 2004).

![Figure 1: Framework for DRR (Source: UNISDR 2004)](image)

The decade-long recurrence of measles outbreaks in the CoCT provided scope for examining the effectiveness of an integrated disaster risk analytic approach in tracing outbreak risk. This presupposed the use of a mixed methods research model that included but was not limited to epidemiological methods. The study rationale was also underpinned by premises about the health sector’s explicit and crucial roles in containing the progression of measles risk. These assumed that identified health sector vulnerabilities in managing measles risk would compromise institutional capacity to avert or manage increases in measles cases, creating conditions favourable for outbreak occurrence (Wisner et al. 2004 and IRGC, 2010). They further assumed that identified institutional vulnerabilities or ‘shortcomings’ could be conceptualised as risk governance deficits and that insights drawn from the identified deficit areas could potentially inform risk reduction efforts that would reduce the risk of measles outbreaks.
3. Reducing Measles Outbreak Risk: Epidemiology and Health Sector Response

Measles, also known as rubeola, is a communicable upper respiratory system infection, caused by the paramyxovirus of the genus Morbillivirus causes measles (Kouadio et al., 2010). Transmission of the virus is airborne through contact with respiratory droplets either directly from person to person, through aerosol transmission, or through surfaces contaminated by the respiratory fluids of an infected person.

On all scales (global, national and district), epidemiological studies have played an integral role in shaping and guiding measles outbreak prevention. While not exhaustive, epidemiological focus in measles risk management can be differentiated into five areas. These include: cause and distribution of severe measles (Morley, 1969a, Coronado et al., 2004, Toole et al., 1989 and Young 2010), measles case management (Morley, 1969b and CDC, 1997), characterisation of infectiousness, specifically, transmission (Grais, 2006 and Koudio et al., 2010), seasonality (Duncan et al., 1999), communicability and herd immunity (Fine, 2003), vaccination and shifts in susceptibility (Morley, 1969a, Koudio et al., 2010, Toole et al., 1989) and measles surveillance (WHO/AFRO, 2004 and 2009). This considerable body of research dates back to Hope-Simpson's study in England and Wales, which provided information on the communicability/contagiousness of measles. He argued that 75.6% [15/20] of household exposures of susceptible contacts lead to measles transmission and modelled measles infectious periods (Hope-Simpson, 1952). Further studies on the transmission of measles have demonstrated that humans are the only known reservoir of the virus (Szusz et al., 2010); as a result, the management of the disease has primarily remained a health sector concern.

These epidemiological findings have guided the development of global and regional strategies to reduce the likelihood of measles outbreaks. They include early global initiatives, such as the Expanded Programme on Immunisation (EPI) and Universal Childhood Immunization (UCI); and the more recent Global Alliance for Vaccines and Children (GAVI), Measles Initiative (MI) and the ‘Accelerated strategy for measles mortality reduction’. They also include regional programmes, such as the southern African catch-up, keep-up and follow-up initiative and efforts to strengthen the routine vaccination coverage through a two-dose measles vaccination schedule in the EPI (Bielik et al., 2002, Coronado et al., 2004, McMorrow et al., 2009, Lopalco and Martin, 2010, Ngcobob and Cameron 2010, WHO, 2010).

While these initiatives have significantly reduced measles morbidity and mortality, they have not successfully eliminated measles transmission (Ngcobo, 2008 and WHO, 2009). Outbreaks still occur, even in industrialised countries with high levels of public health investment (WHO/EU, 2010) and middle income countries with functioning but overburdened health systems (WHO, 2009 and WHO/EU, 2010). Unlike the well-funded or functioning health services provided in industrialised and middle income countries health services in less economically developed countries (LEDCs) are often constrained. Health services in LEDCs therefore aim to provide essential services for disease prevention, treatment and outbreak control (Kruk and Freedman, 2008). In these countries, governments are usually responsible for the administration of vaccines, especially the measles containing vaccine (MCV), through their basic health package. Low vaccination coverage is often then attributed to a lag in health care services.

4. An Integrated Study Design

This study examined the progression of measles outbreak risk from 2000-2011 in the CoCT beyond a limited focus on the hazard (measles virus) and vulnerability (of exposed populations and the health sector to external shocks). Specifically, it investigated district occurrence of measles, with a specific focus on outbreak occurrence by characterising and differentiating the magnitude of identified measles outbreaks. For the decade under study, researchers also identified key health sector shortcomings and risk governance deficit areas associated with the progression of measles risk and recorded outbreak management, examining the results in relation to prevailing epidemiological and disaster risk reduction (drd) approaches.

The study used a multiple case study design to examine both measles outbreak severity and extent as well as health sector deficits that influenced the development of the identified outbreaks. As these elements were complex and cross-disciplinary in nature, a multiple methods approach was used to collect and analyse data. In addition to a detailed epidemiological characterisation of each identified outbreak, the approach was augmented by a range of qualitative research methods. This strategy broadened the researchers' understanding of the CoCT's changing measles risk profile as the combined approaches (qualitative and quantitative) mutually reinforced one another (Creswell, 2009). The epidemiological (quantitative) and other methods applied and their sequencing is illustrated in Figure 2. The Figure summarises the stages in the research process, by outlining the various data types, along with their sources and analysis procedures.

5. Characterisation of Measles Outbreaks 2000-2011: Application of Epidemiological methods

The epidemiological characterisation of measles outbreaks from 2000-2011 in the CoCT was completed in three steps. This involved the confirmation of measles cases from data provided by the National Institute for Communicable Diseases (NICD) and the City of Cape Town’s Health Department (City Health). It also required the differentiation of outbreaks from baseline occurrence and their temporal, spatial and dimensional analysis.

5.1. Suspected and confirmed measles case data analysis

The data-merging process of measles case data identified two major constraints in measles surveillance in the CoCT. First, as South Africa had reached the measles elim-
ination phase and was implementing case-based surveillance, it was expected that all cases in the City Health confirmed measles case (cmc) database would also feature in the NICD database. Unfortunately, analysis of cases in the two databases revealed this seldom occurred, necessitating that the two databases were merged to develop a comprehensive and accurate database for measles occurrence. Initial attempts to merge the two databases signalled a second obstacle. For instance, although all suspected measles cases (smc) should have been assigned a unique identifier code (EPID number), this field was poorly completed (incomplete or not filled in at all) in both the NICD and City Health databases. The process of merging the two databases was further complicated by the lack of alignment between NICD and City Health patient record attributes. Despite these obstacles, the researchers merged the two databases, and after removing duplicates, successfully created a comprehensive line-list of cases. Table 1 illustrates the cmcs recorded in the two separate databases, as well as the cmcs of the two databases after merging and crosschecking for duplicates.

Table 1: cmcs 2000-2011: CoCT

<table>
<thead>
<tr>
<th>Year</th>
<th>NICD</th>
<th>City Health</th>
<th>Line-list total/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>0</td>
<td>69</td>
<td>69</td>
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<td>19</td>
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<td>40</td>
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<td>33</td>
<td>27</td>
<td>42</td>
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<td>10</td>
<td>45</td>
<td>55</td>
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<tr>
<td>2006</td>
<td>0</td>
<td>36</td>
<td>36</td>
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<tr>
<td>2007</td>
<td>1</td>
<td>13</td>
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</tr>
<tr>
<td>2008</td>
<td>1</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td>2009</td>
<td>167</td>
<td>101</td>
<td>240</td>
</tr>
<tr>
<td>2010</td>
<td>1403</td>
<td>905*</td>
<td>2308</td>
</tr>
<tr>
<td>2011*</td>
<td>9</td>
<td>c</td>
<td>9</td>
</tr>
</tbody>
</table>

* Database contains 6,137 smcs (which are excluded in this table as the WC stopped sending smcs for laboratory confirmation

*b Up until May 2011

*c No data

5.2. Differentiating measles outbreaks from baseline occurrence

For the ten years under study, specific measles outbreaks were differentiated from baseline occurrence patterns by identifying periods characterised by an increase in number of measles cases (WHO/AFRO, 2004). However, in the absence of set case or morbidity rate, nor specific guidelines on methods for determining an ‘increase’, Table 2 presents the two criteria (clustering of cmcs and inter-quartile range) used in this study to identify and determine measles outbreaks. These criteria considered temporal (2000-2011), spatial (CoCT) and annual total cmcs (2000-2011). Subsequently, an outbreak was defined as any period in which more than 32 cases occur within 30 days of each other, while the baseline/threshold was determined by the use of the inter-quartile range of the data.

Table 2: Criteria for measles outbreak identification

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Rationale</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clustering among cmc</td>
<td>Only reported smcs and cmcs</td>
<td>Cmcs occurring in the same district with an onset within 30 days of each other (Biellik et al., 2002)</td>
</tr>
<tr>
<td>Inter-quartile range</td>
<td>To differentiate between the baseline and threshold occurrences and also include all cases</td>
<td>Inter-quartile range all clusters of cmcs that equal to or are more than 32 characterised outbreak occurrence</td>
</tr>
</tbody>
</table>

5.3. Temporal, spatial and dimensional outbreak analysis

Once the outbreaks were identified, outbreak analysis applied three analytical categories. The temporal analytic category determined the frequency and duration of out-
breaks in the study period. The dimensional analytic category determined the intensity of the outbreaks through calculation of incidence rates during outbreaks in the sub-districts. The spatial analytic category determined the location and extent of the outbreaks in the eight CoCT sub-districts (Köhler et al., 2004).

Temporal analysis was undertaken following the consolidation of data into line-lists and the application of the parameters to distinguish between baseline and epidemic occurrence of measles. Subsequently, three outbreaks were identified in the study period. Epidemic curves and single variant analysis were used for person variables: age-group and sex.

Dimensional analysis of incidence by age-group and sex was enabled through the development of population pyramids to identify vulnerable groups. Spatial analysis of measles incidence sought to establish the spatial extent of the outbreaks and identify vulnerable areas. Using only the City Health database, measles occurrence patterns were determined at sub-district level. Sub-district population and cmc data were used to calculate incidence rates per 100,000 population during outbreaks using Equation 1:

\[
\text{Incidence} = \frac{\text{Number of cms in sub district during outbreak}}{\text{Total population in sub district}} \times 100,000 \quad (1)
\]

The incidence rates were entered into an Excel workbook and were joined to the shapefiles’ attribute tables for CoCT sub-district. Once joined, the measles incidence per 100,000 population by sub-district was illustrated in the maps. These incidence rates were classified into five clusters (0-5/100,000, 6-10/100,000, 11-20/100,000, 21-30/100,000 and 30+/100,000) to portray the change in measles incidence by sub-district in the three outbreaks. Individual maps were made for each of the three outbreaks.

5.4. Qualitative data for determining health sector vulnerabilities

A wide range of qualitative data sources were used, incorporating both document review and key informant interviews. Iterative document review constituted a crucial element of research process, identifying the types of data to be collected from key-informants and guiding the selection of thematic areas for key informant interviews. Documents reviewed included: publicly available communicable diseases surveillance bulletins, health policy documents, annual health services organisational and financial reports. They also included governmental and non-governmental documents that contained information from standardised surveys and professional reports.

These data were complemented by key informant interviews with representatives from three spheres of government with measles-related investigative and reporting responsibilities (national surveillance, provincial EPI and district authority). This was undertaken through a standardised open-ended interview guide comprising six thematic areas. Illustrative themes included; measles outbreak prevention and response services; measles outbreak control strategies, measles outbreak prevention and preparedness strategies and resource diversion related to measles elimination strategies. Interview data were recorded then transcribed, with responses clustered according to the guiding themes. A narrative was developed for each outbreak response.

Qualitative data were subsequently analysed through stakeholder and historical analysis. Stakeholder analysis generated a profile of the different health sector actors’ intentions, agendas, activities, partnerships and resources related to measles outbreak risk (Varvasovszky and Brugha, 2000). Historical analysis complemented this process by tracing how institutional stakeholders’ visions and strategies developed over time, to reveal temporal changes (Babbie and Mouton, 2001). Government documents that contained information from standardised surveys and professional reports were used for these analyses. Health sector shortcomings that escalated the severity of measles outbreaks were also identified. These were grouped according to the level of authority responsible (national surveillance, provincial EPI, subdistrict authority and health worker) and were organised around themes such as routine and mass immunisation, outbreak notification procedures and perception of outbreak response priority.

6. Results: Integrating epidemiological and risk governance findings 2000-2011

Research results indicated three identifiable measles outbreaks of increasing duration and spatial extent. Findings also signalled persisting risk governance deficits associated with increasing outbreak severity over the ten years studied.


In 2000, 69 measles cases were recorded in the City Health Department cmc database. These cases, however, were not reflected in the national surveillance cmc database2. The researchers could not locate any formal reports documenting the circumstances surrounding the outbreak. Temporal analysis of the 69 cases revealed that between January and May 2000, a measles outbreak resulted in 45 cmcs aged from 6 months to 19 years (Figure 3). Children aged 1 to 4 years were most affected, with an overall incidence rate of 8 per 100,000 population (Figure 4). This limited outbreak occurred in four sub-districts of the CoCT: Eastern, Northern, Tygerberg and Western. The overall reported incidence in these four sub-districts was 3 per 100,000 population. Tygerberg sub-district had the highest incidence rate of 6 per 100,000 population (Figure 5).
6.2. Outbreak II: September 2004-March 2005

This outbreak, reported in the CoCT in September 2004, could be traced to the introduction of a measles case from Mozambique and subsequent outbreak in May 2003 in Gauteng (with localised limited outbreaks in the provinces of KwaZulu-Natal, Mpumalanga, and Northern Cape). The CoCT outbreak occurred despite a national mass measles vaccination campaign conducted between July and August 2004 that administered MCVs to all children under 5 years of age. Sporadic cases were reported (in January, March and May) in Klipfontein and Western sub-districts. However, only after a case presented in the Imizamo Yethu informal settlement in the Southern sub-district, did outbreak conditions escalate.

The outbreak began in September 2004 and ended in March 2005, resulting in 91 reported cmcs (Figure 6). High incidence rates were reported in the 20 to 29 years and less than one year of age groups. Women 20 to 29 years of age had the highest incidence (9 per 100,000 population) followed by males under 1 year of age (6 per 100,000 population) (Figure 7). Cases were reported in four of the city’s eight sub-districts: Northern, Klipfontein, Southern and Western with an overall incidence rate of 3 per 100,000 population in the four sub-districts. Southern sub-district reported the highest incidence of 9 per 100,000 population (Figure 8).
Two outbreak prevention and control measures were instituted during 2004-2005; contact tracing and mass immunisation in Imizamo Yethu, Hout Bay and Fish Hoek. The outbreak spread to Fish Hoek where the reported immunisation coverage was less than 30%. This was attributed to the reluctance of parents in the area to vaccinate their children. Such perceptions were countered by vaccination promotion articles by a local GP published in their local newspaper (ibid). In Imizamo Yethu, teams of nurses actively encouraged parents to bring their children for vaccination.

6.3. Outbreak III: May 2009-February 2011

In May 2009, a measles epidemic began in Cape Town soon after an outbreak was reported in Gauteng. From 2009 to 2011 (Figure 9), 2,539 measles cases were confirmed with an incidence of 27 per 100,000 population. Only 2,396 (94%) cases could be characterised by age and sex. Children under the age of 1 year were the most severely affected, reporting incidence rates of 2,779 per 100,000 population. This was almost ten times more than the second highest rate of 285 per 100,000 population in the 1 to 4 year age group (Figure 10). Measles cases were reported throughout the CoCT in all sub-districts. Particularly high incidence rates were recorded in the Western, Khayelitsha and Southern sub-districts with incidence rates in excess of 31 per 100,000 population (Figure 11).

The 2009-2011 measles outbreak was primarily managed through outbreak response. Measures utilised included enhanced surveillance, outbreak case management and social mobilisation for Outbreak Response Immunisation (ORI). The National DoH also requested intensified reporting and laboratory confirmation of cases throughout South Africa. The NICD used this opportunity to contact laboratories and practitioners and increase awareness of the notification procedures mandated by law. It also encouraged reporting, providing online surveillance reports.

The first of two ORI campaigns was initiated by the Western Cape DoH, and targeted known high-risk areas. The second, by the National DoH, targeted all children between 6 months and 15 years, throughout the CoCT. The social mobilisation primarily promoted the ORI, with assistance of faith-based groups. During the first ORI, social mobilisation focused on promoting the campaign through health talks on radio and distribution of posters and pamphlets (ProMED, 2010a). More intense health promotion strategies, including radio broadcasts and advertisements, and print media feature articles were applied during the national mass immunization.

Informal settlements were flagged as high-risk areas. Refugees were identified as high-risk and hard to reach groups and reached through refugee organizations. Pamphlets were translated into French, Lingala, Portuguese, Somali and Kiswahili; while difficult to reach South African groups were accessed through translated Afrikaans and isiXhosa fliers. To manage severe measles cases and prevent nosocomial transmission in CoCT two measles isolation wards with a capacity of 30 patients were opened at New Somerset and Tygerberg Hospitals (ProMED, 2010b).
7. Comparative epidemiological attributes

Despite these intensive response measures, the 2009-2011 outbreak constituted the most serious and extensive epidemic, whose duration (575 days) was more than three times longer than those in 2000 and 2004-2005. Its overall incidence (27 per 100,000 population) was also more than nine times that of the earlier epidemics, while its spatial extent (8 sub-districts) doubled those of the preceding outbreaks. The results also suggest deteriorating capacity of the health sector to protect the CoCT from measles epidemics, indicated by the progressive increase in the duration, incidence and spatial extent over the ten-year study period.

Table 3 lists the outbreak severity and extent attributes identified for the three outbreaks. It shows that the 2009-2011 outbreak was the most severe.

8. Identification and classification of internal institutional constraints

Study results also revealed twenty-five health sector institutional shortcomings in outbreak risk management across the three epidemics. Table 4 on page 236 clusters these by thematic area (routine immunisation, mass immunisation, notification procedures and outbreak control emphasis) and administrative level (national, provincial, district and health worker). This enables identification of recurring sectoral constraints that cut across all outbreaks as well as limitations that emerged in 2009-2011.

8.2. Emerging shortcomings

Emerging institutional shortcomings represented constraints that became apparent only in the 2009-2011 outbreak. At national surveillance level, these included a lack of ‘surge protection’ plans for laboratory testing and diagnosis during enhanced surveillance for outbreaks. At provincial EPI level, this included delays in mobilising teams for outbreak response, attributed to restructuring of the District Health System (DHS). This delayed the development and planning of micro-immunisation plans. At health worker level, the problem was poor completion of case investigation forms. This was particularly serious as it constrained the outbreak characterisation of cases. Moreover, in the 2009-2011 outbreak, health workers failed to identify and delayed diagnosing the index case. This crucially delayed smc’s response and intervention limiting the effectiveness of measles contact tracing and activation of ORI.

8.3. Shortcomings that have been reduced

There is however, encouraging evidence of some strengthened capacity, as indicated by improved management in the most recent outbreak. At national surveillance level, in the 2009 outbreak, there was active enforcement and awareness-raising on surveillance and reporting protocols to improve outbreak detection, spread and reporting (by contacting private laboratories and hosting practitioner forums). At Provincial EPI level, in 2009, there was evidence of improved MCV vaccination coverage in mass/outbreak immunisation through radio broadcast, local newspapers and pamphlet distribution. This was also enabled by social mobilisation with high-risk areas and advertising directed to high risk/difficult to access groups (eg. refugees).

9. Discussion


A central element in both outbreak investigation and ex-post disaster studies is the characterisation of the disaster (or outbreak) event by its temporal and spatial attributes as well as magnitude and impacts (Coetzee et al., 2007 and Holloway et al., 2010). Study results indicate the occurrence of three clearly differentiated measles outbreaks between 2000 and 2011. The first two outbreaks, in 2000 and 2004-2005, were spread across four sub-districts, with incidence rates of 3 per 100,000 population. These contrast markedly with the 2009-2011 outbreak, which was dispersed across all sub-districts and reported considerably higher incidence rates of 27 per 100,000 population. This outbreak took almost two years to control.

These findings, which indicate increasing outbreak extent and severity, are juxtaposed against reports of significantly improved MCV coverage in the CoCT during the same period. This apparent contradiction between the increasing severity of each successive outbreak on one hand...

<table>
<thead>
<tr>
<th>Thematic deficiencies and failures</th>
<th>Institutional constraints identified by reporting level</th>
<th>2000</th>
<th>2004-5</th>
<th>2009-11</th>
</tr>
</thead>
<tbody>
<tr>
<td>National surveillance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notification procedure</td>
<td>Staff shortages in lab testing and reporting</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Poor enforcement of surveillance reporting protocols</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Inadequate monitoring on completeness of CI form</td>
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<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Provincial EPI</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Routine immunisation</td>
<td>Focus/investment on mass rather than routine vacc.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Planning using low client numbers</td>
<td>✓</td>
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<td>✓</td>
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<tr>
<td>Mass immunisation (ORI and SIAs)</td>
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</tr>
<tr>
<td></td>
<td>Constraints/delay in organising teams for ORI</td>
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<td>-</td>
<td></td>
</tr>
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<td>Poor media coverage</td>
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<td></td>
<td>Staffing shortfalls</td>
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<td>Notification procedure</td>
<td>Failure to raise awareness on notification procedures</td>
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<tr>
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<td>Failure to conduct outbreak response vaccination</td>
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<tr>
<td></td>
<td>Failure to detect outbreak</td>
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<td>Failure to report on outbreak</td>
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<td>Outbreak control priority</td>
<td>Focus on H1N1 outbreak threat</td>
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<td>-</td>
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<td>District/sub-dist. authority</td>
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<tr>
<td>Routine immunisation</td>
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<tr>
<td>Mass immunisation (ORI and SIAs)</td>
<td>Failure to reach 90% vaccination coverage</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Hard to reach areas/high risk groups not targeted</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Staff shortages</td>
<td>-</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>Notification procedure</td>
<td>Incomplete case response</td>
<td>-</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>Health worker</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass immunisation (ORI and SIAs)</td>
<td>Poor EPI practices</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Incomplete case response</td>
<td>-</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Poor completion of case investigation forms</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Poor/constrained adherence with notification protocols</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
</tbody>
</table>

and improving measles vaccination on the other directs attention to other possible shortcomings internal to the health sector that may have increased the likelihood of measles outbreak occurrence.

9.2. Identified health sector deficits related to measles outbreaks: Focus on emerging and recurrent shortcomings

As described, risk governance refers to structures and processes to identify, assess, manage and communicate multifaceted risk processes across multiple actors (Renn, 2008 and IRGC, 2010). The effectiveness of these systems may however be compromised by risk governance deficits which constitute deficiencies or failures in the identification, assessment, management or communication of risks, which constrain the effectiveness of the risk governance process (ibid). The IRGC proposes 23 distinct risk governance deficit areas distributed between risk understanding/assessment and risk management (action) processes.

This study identified 25 internal health sector shortcomings that resulted in either deficiencies or failures in measles outbreak risk governance processes in the health sector. These were distributed across all four service implementation levels and predominantly applied to perception of outbreak priority, notification procedures and mass vaccination campaigns. Three emerging and recurring shortcomings related specifically to assessing and understanding measles outbreak risk included failure to ensure adequate factual knowledge for robust risk assessment, failure to detect early warning signals and failure to recognise and keep-up with fast changes to a system.

The failure to ensure adequate factual knowledge for robust risk assessment occurs when there is inadequate knowledge about a hazard, including the probabilities of adverse events and associated consequences (IRGC, 2010). The IRGC (2010) suggest that this may compromise subsequent risk management decision making. Study findings indicated an over-reliance on immunisation coverage data to inform measles risk management decision making and assess performance of the District EPI programmes. Study findings indicated continued use of inaccurate population estimates/client numbers. The use of low client numbers in particular, results in the reporting of inflated vaccination coverage and compromises the quality and reliability of MCV coverage data (Corrigall et al., 2008 and Ngcobo, 2008). In a review of routine immunisation coverage in the Western Cape, Corrigall et al., (2008) explain the impact of low client numbers on estimates of MCV coverage. They argue that the use of live-birth data as a denominator to determine MCV coverage rather than census data inflates coverage estimates. In the case of the CoCT, important discrepancies between live-birth and census data may be attributed to the fast-paced character of recent urban growth in the CoCT, increasingly affected by in-migration (Pharoah, 2009).

Constrained detection of early warning signals may
also have serious risk management consequences. Although timeous notification of measles cases has contributed a central element of outbreak detection and response (Cutts et al., 1991; WHO, 1999; WHO, 2009 and IRGC, 2010) this study identified several deficiencies related to notification procedures. As listed in Table 4, these included incomplete case response at the beginning of the 2000 and 2004-2005 outbreaks.

The 2009-2011 outbreak was characterised by failures in notification procedures, particularly incomplete and subsequent underreporting of measles cases, which resulted in failure to interrupt measles transmission. In an earlier study of doctors in KwaZulu Natal, Abdool Karim and Dilraj (1996) illustrated similar consequences of under-reporting and incomplete notification. These failures had direct consequences for health authority appreciation of the extent of measles incidence, thus reducing the urgency to control measles cases (Abdool Karim and Dilraj, 1996 and IRGC, 2010).

The failure to recognise and keep-up with fast changes to a system particularly applies to dynamic risk environments where fundamental changes go undetected because “analysts and decision makers do not expect or recognise them” (IRGC, 2010). It is generally known that since the global introduction of the measles vaccine there has been a lengthening of intervals between measles outbreaks and marked reductions in measles incidence (Cutts et al., 1991). However, improved immunisation coverage has not been the only reason for reduction in measles cases. Corrigall et al. (2008), state that health-facilities have played an integral role in interrupting measles transmission through case response. Due to these two interventions and associated reduction in measles incidence, more recent cohorts of nurses and doctors have never seen measles cases (Corrigall et al., 2008). The CoCT study illustrated a new dynamic failure that led to the progression of the 2009-2011 measles outbreak; this failure was inability by health workers to diagnose the index measles case.

These findings on shifting risk perception, capacities and knowledge based on a lengthening inter-epidemic interval are consistent with lessons drawn from disaster risk literature on long recurrence intervals (eg. earthquakes and tsunamis) and overconfidence in infrastructural interventions that ‘keep hazards away’ for specific threats (Smith and Petley, 2009).

9.2.1. Health sector deficits related to measles outbreaks: risk identification and risk management

The failures described above related to early warning systems help explain many of the factors that exacerbated the measles outbreaks. However, they do not fully explain the outbreaks’ progressions. In particular, the delayed management of the 2009-2011 measles outbreak was not only attributed to the misreading of early warning signals. Epidemic conditions escalated rapidly due in part to health authorities failing to prioritise measles outbreak response. In relation to actual measles outbreak risk management, the study identified lack of organisational and administrative capacity to ensure effective management and failure to design effective management strategies.

In general, the lack of organisational capacity to manage risk constitutes a significant deficit area. Study findings indicate this constituted an important, recurrent deficit area in the CoCT, illustrated by delayed planning for ORI and SIA campaigns. Although WHO (2009) stresses timely planning for mass campaigns to ensure the availability of key staff, vaccine and other supplies which are integral to ‘high quality large-scale SIA’, evidence from this research suggests there were failures in timely planning. These compromised efforts to secure administrative and organisational capacity for effective mass immunisation campaigns.

The IRGC (2010) suggests that effective risk management requires objectives, accompanied by clear strategies, plans and measures to achieve these. Deficits occur when risk management strategies are poorly defined. In the context of measles outbreak management, pockets of low immunisation coverage represent populations at-risk of measles infection and outbreaks (Corrigall et al., 2008). Therefore, measles risk management strategies need to specifically address these high-risk groups. However, study findings reveal that, over the years, the integrity of SIA and ORI campaigns had been compromised by failures to locate and effectively reach high-risk pockets of susceptible populations. This was evidenced in the 2004-2005 measles outbreak which occurred a month after the SIA, in which, 70% of the under-fives who were diagnosed with measles were in the national campaign’s target group. Encouragingly, purposive ORI efforts in 2009-2011 to reach high risk groups signal increasing recognition of this response priority.

10. Conclusion

This study explored the applicability a more integrative disaster risk analytic perspective to the management of recurrent communicable disease outbreak risks through the lens of a decade of measles outbreaks in the City of Cape Town (CoCT), South Africa. It applied a mixed methods research model to characterise the progression of measles outbreak risk from 2000-2011 that included but was not limited to epidemiological methods. The study also probed identified health sector vulnerabilities in managing measles risk, arguing that these institutional shortcomings could be conceptualised as risk governance deficits and that insights drawn from the identified deficit areas could potentially inform risk reduction efforts to reduce the risk of measles outbreaks.

Study findings underline the value of detailed ex post outbreak research. This includes the contribution of epidemiological analysis, which in the CoCT study, revealed the rising severity of measles outbreaks, along with increasing duration and spatial extent. However, while such results indicate the necessity of epidemiological analysis, they also suggest that the application of epidemiological methods alone is insufficient to inform robust risk management planning – even for threats viewed as health sector-specific.

The incorporation and application of the concepts de-
rived from risk governance substantially augmented the epidemiological findings on measles outbreak occurrence. Specific information on risk governance deficits during the study period identified crucial health sector limitations that compromised capacity to avert or manage increases in measles cases, escalating prospects for outbreak occurrence. This was clearly illustrated by the systematic underestimation of client numbers during the 2009-2011 outbreak due to an over-reliance on live-birth data, and which compromised the accuracy of factual knowledge for assessing the risk of measles outbreaks.

Insights derived from the application of a risk governance deficits approach also allow for strengthened anticipatory management of measles outbreak risks. They enable measles outbreak risk management to ‘push back’ from its current, limited focus indicated by the dark shading in Figure 1 into strategic aspects of ongoing health sector programming.

In this context, this study and its results underscore the value of applying a broader disaster risk lens to the investigation of measles outbreak risk. Such holistic perspectives, also illustrated by the OneHealth integrative risk management approach (Barrett et al., 2011) offer particular promise in addressing increasingly complex and interconnected health risks faced now and in the future.

References


Citation