Using social network analysis to examine the decision-making process on new vaccine introduction in Nigeria

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The decision-making process to introduce new vaccines into national immunization programmes is often complex, involving many stakeholders who provide technical information, mobilize finance, implement programmes and garner political support. Stakeholders may have different levels of interest, knowledge and motivations to introduce new vaccines. Lack of consensus on the priority, public health value or feasibility of adding a new vaccine can delay policy decisions.

Efforts to support country-level decision-making have largely focused on establishing global policies and equipping policy makers with the information to support decision-making on new vaccine introduction (NVI). Less attention has been given to understanding the interactions of policy actors and how the distribution of influence affects the policy process and decision-making.

Social network analysis (SNA) is a social science technique concerned with explaining social phenomena using the structural and relational features of the network of actors involved. This approach can be used to identify how information is exchanged and who is included or excluded from the process.

For this SNA of vaccine decision-making in Nigeria, we interviewed federal and state-level government officials, officers of bilateral and multilateral partner organizations, and other stakeholders such as health providers and the media. Using data culled from those interviews, we performed an SNA in order to map formal and informal relationships and the distribution of influence among vaccine decision-makers, as well as to explore linkages and pathways to stakeholders who can influence critical decisions in the policy process.

Our findings indicate a relatively robust engagement of key stakeholders in Nigeria. We hypothesized that economic stakeholders and implementers would be important to ensure sustainable financing and strengthen programme implementation, but some economic and implementation stakeholders did not appear centrally on the map; this may suggest a need to strengthen the decision-making processes by engaging these stakeholders more centrally and earlier.

Keywords Policy analysis, vaccine policy, social network analysis, new vaccine introduction, developing country, Hib vaccine, pneumococcal conjugate vaccine, rotavirus vaccine
KEY MESSAGES

- Social network mapping can be useful for examining how vaccine policy makers in Nigeria interact and influence each other.
- The visual nature and systematic approach of social network mapping provides insights for policy makers and programme managers, and can guide strategies to engage key stakeholders.
- In particular, the Ministry of Finance and other policy actors who control finance allocation could be engaged more at an earlier stage.
- Likewise, state-level actors who drive implementation could be brought into the decision-making process at the federal level to ensure that policy decisions taken centrally have strong support for implementation locally.

Introduction

Advances in vaccinology have ushered in new vaccines against common causes of childhood morbidity and mortality. Access to these vaccines within low-income countries (LIC) is sometimes hampered by their delayed inclusion in national immunization programmes. Routine use of Hepatitis B and Haemophilus influenzae type b (Hib) lagged by over a decade in developing countries—an indication that having a safe, efficacious and cost-effective vaccine in the global market is not enough to guarantee LIC's access to cost-effective vaccines that have the potential to save a large number of lives (Watt et al. 2003; Levine et al. 2004; Duclos et al. 2009; Ojo et al. 2010).

The decision to introduce a new vaccine is dependent on a number of factors. Levine et al. (2010) have proposed a framework of evidence-to-policy-to-implementation for accelerating new vaccine access. First establishing and organizing the evidence base, including data on local disease burden, vaccine impact in routine use and cost-effectiveness; then establishing supportive global policies [e.g. World Health Organization (WHO) position statements and recommendations]; and finally, translating polices to local action.

The translation of evidence to policy and then to local implementation requires action from a variety of stakeholders who may possess different levels of knowledge, interest and motivation regarding new vaccines. Inability to reach consensus may therefore slow vaccine adoption (Pliso and Wild 2009). Supporting the policy process for new vaccine introduction (NVI) must provide the information relevant for introduction decisions, while remaining sensitive to the non-technical drivers of policy decisions such as networks and influencers of decision-makers.

To that end, stakeholder analyses can characterize the power and positions of key players, describing the role stakeholders play in influencing various policy decisions. Brugha and Varvasovsky (2000) describe it as a tool to facilitate the implementation of policy and to predict the feasibility of certain policy options or direction. Hyder et al. (2011) describe a series of stakeholder analyses designed to help strengthen the research-to-policy interface.

Social network analysis (SNA) is a research methodology and theoretical paradigm concerned with explaining social phenomena using the structural and relational features of the network of actors involved. Like traditional stakeholder analysis, SNA provides an understanding of the goals, characteristics and relative influence of relevant groups and individual actors. In addition, the SNA adds value by characterizing the linkages between those actors, particularly in terms of how information is exchanged and who is included or excluded from the process.

With its emphasis on interaction between stakeholder groups, SNA has roots in pluralist theories of policy analysis, though it is as applicable to small, homogeneous networks as to large heterogeneous policy systems. It has been suggested that SNA is a more robust specification of Sabatier’s Advocacy Coalition Framework (Sabatier and Jenkins-Smith 1993) at both the methodological and theoretical level (Fueg 2008). As such, it has more in common with network theories of policy making than with traditional stage models (Carlsson 2000), though discrete stages may be abstracted from a broader network model. While SNA may not illustrate non-network influences on policy making (such as catalytic events), it can shed light on the likely processes by which a system of actors will react to such external stimuli.

Drawing on mathematical graph theory and classical sociology (Luke and Harris 2007), social network analysis has been applied in different public health disciplines. Recent SNAs have studied the transmission of sexually transmitted infections (Laumann and Youm 1999) and HIV (Morris et al. 2006) and the epidemic spread of obesity (Christakis and Fowler 2007). SNA has also been used to explore social networks in relation to social support, social capital (Lin 1999) and the diffusion of medical innovation (Miguel and Kremer 2003).

In the field of public policy and organizational behaviour, SNA has been used to examine public health systems (McKinney et al. 1993) and network governance (Toikka 2009). Political scientists have used SNA to explore how the structure and organization of policy networks influence policymaking performance (Sandström 2008) and how access to networks influences the feasibility of political action (Christopoulos 2006). Use of SNA in vaccine policy is recent and limited to one study examining the speed of new vaccine adoption in two middle- and low-income countries (Conway et al. 2008).

Current SNA literature suggests that while social processes may be governed by explicit rules and codes, they are also shaped by relational ties between actors. These ties serve as a conduit for resources and information, which create or constrain opportunities for individual or collective action (Lin 1999). Formal analyses of social networks employ a number of network concepts such as centrality, structural holes, fluidity and density to explain outcomes of interest (Burt 1992;...
Wasserman and Faust 1994). This study presents a more applied use of SNA; we employ it as a heuristic device to identify and characterize key players, quantify perceived influence and outline pathways to accessing these key players. Elucidating the interaction of policymakers could inform better strategies to engage them effectively and support their decision-making regarding NVI.

Background
This study was conducted in Nigeria, a country with over 150 million people and nearly 6 million annual births. In 2009, under-5 mortality rate was estimated at 157 per 1000 live births (FMOH and NPHCDA 2009); the combination of high child mortality and a large birth cohort makes Nigeria a disproportionate contributor to the global burden of under-5 deaths.

In line with global, regional and Millennium Development Goal 4 (MDG4) targets, Nigeria’s immunization goals are to attain 80% coverage of all antigens in 80% of districts, interrupt transmission of vaccine-derived and wild polio virus by 2012 and introduce Hib and pneumococcal conjugate vaccine (PCV) to fast track reduction in child mortality by 2015.

The National Primary Health Care Development Agency (NPHCDA), a parastatal under the Federal Ministry of Health (FMOH), is responsible for immunization activities in the country. The federal government (FG) pays for all routine vaccines from immunization budgets appropriated by the federal legislature and disbursed to the FMOH by the Federal Ministry of Finance (FMOF). Through the NPHCDA, the FG provides overall policy direction and technical support, while the states and local government provide logistics and human resources to implement routine immunization at health facilities. Several international and national organization support immunization programmes; for example, the GAVI Alliance subsidizes the cost of new vaccine and funds immunization and health system support, while Rotary International and the Bill & Melinda Gates Foundation have supported polio eradication.

Nigeria is one of the late adopters of Hib vaccines in Africa. Much of the delay was due to its inability to meet the minimum DTP3 coverage requirements to obtain new vaccine support through GAVI. In fact, Nigeria moved relatively quickly to respond after reaching the eligibility threshold. After two previous unsuccessful attempts, in 2011, Nigeria obtained GAVI support to introduce Hib vaccine in 2012, along with conditional approval for PCV. The decision to introduce Hib and PCV was the culmination of a series of consultations with international and local partners beginning with a visit in 2008 by staff from the WHO, Hib Initiative, PneumoADIP and the US Centers for Disease Control and Prevention (CDC). In the absence of a National Immunization Technical Advisory Group (NITAG), a New Vaccine Committee with membership from the NPHCDA, WHO, UNICEF, development partners and a network of local researchers and disease experts was constituted in 2008 and tasked with developing a recommendation for Hib and PCV introduction (NPHCDA–NUVI presentation, June 2011). Following consultations with stakeholders, the NPHCDA presented the recommendation to the Inter-Agency Coordinating Committee (ICC) for ratification. The ICC is an advisory body that co-ordinates immunization activities in Nigeria, chaired by the Federal Minister of Health and comprising governmental, non-governmental and international partners involved in immunization. Despite the technical consensus achieved, advocacy to the presidency, the legislators and the FMOF was needed to ensure budgetary allocation for new vaccine co-pays.

Aims and objectives
The study was an effort to support the government of Nigeria in its decision-making for NVI. Using the decision to introduce Hib vaccine as a case study, we visually illustrate the interactions of vaccine policy actors, highlighting the relative influence of various stakeholders in order to provide insight into the policy process. The study was done with the knowledge and collaboration of the government of Nigeria, with the intent of sharing the results with them and the ICC. We chose to analyse the decision-making process at the state and federal level in order to confirm perceptions about how the process was working. Additionally, our team used this information to identify possible groups that were excluded from the process that could otherwise be engaged for future policy decisions on NVI.

Methodology
We conducted the study at federal level in the capital city of Abuja and in two states, Lagos (south) and Kano (north). Both are influential states, each with a population of about 10 million people. In addition, Kano is significant for being the epicentre of the 2004 mass rejection of polio vaccination by some northern communities in Nigeria.

This was a mixed methods study using qualitative [key informant interviews (KIIs)] and quantitative (survey) data collection methods.

Data collection
We interviewed key informants from the FMOH, NPHCDA, WHO, UNICEF and other immunization agencies. Key informants were identified based on discussions with contacts in these organizations, a desk review and a review of the Vaccine Information Management System (VIMS) contact database. This database is maintained at the International Vaccine Access Centre (IVAC) of Johns Hopkins School of Public Health (http://www.jhsph.edu/ivac/vims.html). A total of 10 KIIs were conducted with mid or upper-level immunization programme managers, individuals involved in vaccine decision-making or individuals working on immunization and judged by our contacts to have good knowledge of the health system. The interviews were conducted using a semi-structured interview guide. The objectives of the interviews were to: (1) describe the vaccine decision-making process in Nigeria, identifying individuals, agencies and institutions involved and their roles; and (2) initiate sampling for the social network survey.

Social network survey
We administered a second shorter quantitative interview to a larger group of individuals. A social network roster was developed from document review and KIIs. We defined the network boundaries as persons who were involved or influential in the decision to introduce pentavalent vaccine in the
country. Snowball sampling was used to generate the names; we stopped sampling after two rounds when we reached saturation (Doreian and Woodard 1992). Our starting list was diverse, including individuals from different organizations and backgrounds to minimize sampling bias.

All interviews and surveys were conducted in person by two experienced interviewers. Both interviewers were trained to minimize interviewer bias and the survey tool was pretested to ensure standard questions and consistent responses. We sought to elicit information on each actor’s interactions with other actors on the roster, capturing five main types of interactions: information flow, advocacy, formal control, funding and gatekeeping. (Questions: Who are the actors involved in the decision to introduce new vaccines? How about in the implementation once the decision has been made? Which of these players do you interact with? Which of the following describes your primary form of interaction with each actor, and in what direction is the interaction? Who influences who regarding this type of interaction? Is it provision of information regarding vaccine introduction, advocacy to increase support for vaccine introduction, formal or official control in your normal line of duty, provision of funds, or a gatekeeper function, i.e. one actor serves as the conduit or access for the other?)

We also asked about the degree of influence other actors had on each interviewee’s vaccine introduction decisions. Respondents were asked to score each actor on a discrete analog influence scale of 0 to 10, with 0 being no influence and 10 being most influential. (Question: How much influence does each actor have on your vaccine introduction decisions? Please rate each on a scale of 0 to 10, with 0 being no influence whatsoever on you and 10 being maximum influence).

Data analysis

We coded and analysed qualitative data by themes. The findings from the thematic analysis of the qualitative information are used in this report as background information and to support findings from the SNA. The survey data was entered and cleaned in Microsoft Excel 2007 and Notepad 2007, and transferred to Netdraw (http://www.analytictech.com/) to generate the network maps.

In the network maps, each circle/node represents an actor (institution, groups of institutions, or groups of persons). Nodes are colour-coded according to the type of stakeholder. The size of the node reflects the level of influence. The presence of a tie (arrow) represents interaction between two nodes as described above; the direction of the arrow indicates the direction of influence associated with the primary interaction reported, in this paper, we focus on information exchange. The arrow points to the node being influenced. For example, if the primary form of interaction between node 1 and 2 is provision of information, and node 2 reports being influenced by the information provided by node 1, then the arrow will point to node 2. Because we take account of the direction of influence, the maps are ‘directed’ networks.

Although we gathered information from individuals, we used institutions as the unit of analysis. We assumed respondents were representative of their institutions because peoples’ roles in vaccine decision-making tended to be defined by their official roles and institutional affiliations. In the cases where multiple individuals from an institution received different influence scores (e.g. NPHCDA and FMoH), we defaulted to the highest score within the institution, assuming the institution is at least as influential as its most influential member.

We report basic node and network level statistics—such as order (number of actors), size (number of non-zero ties), density (proportion of all possible ties that exist), degree (number of ties in or out of an actor) and centrality. Degree is one of the simplest measures of centrality, reflecting the prominence of actors in a network. Actors who are highly central have many connections to others in the network and are therefore well positioned, to give or receive information, to wield influence or to mobilize or deploy resources.

Ethical considerations

This was study was presented to the Johns Hopkins Bloomberg School IRB and granted IRB exemption as a public health practice research since information sought was about institutions not individuals and policy processes not people’s behaviors. To protect respondents’ confidentiality, we do not report names and positions, only institutions and type of institution. The Minister for Health is the only exception in which we reported the position.

Results

Description of study sample

We interviewed a total of 38 individuals from a variety of institutions including governmental and private institutions; bilateral, multilateral and donor agencies, and individuals. Twenty-two of the respondents were based at the federal level in Abuja and 16 at the state level, specifically Lagos (9) and Kano (7) states.

<table>
<thead>
<tr>
<th>Type of actor</th>
<th>Primary focus of actor</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Health</td>
<td>Development</td>
</tr>
<tr>
<td>Government (Federal and State)</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Professional health association</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Private institutions/individuals</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Bilateral, multilateral and donor agencies</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
<td>6</td>
</tr>
</tbody>
</table>
Results are presented separately for the two networks, the vaccine introduction network (operating at federal level) and the vaccine programme implementation network (operating at state level).

Network composition
Vaccine introduction network
The network composition is mixed. Of 29 actors identified (Table 1), the majority 16 (55%) were primarily health-sector focused, including state and federal-level actors like the Minister for Health, the NPHCDA, the FMoH and state Ministry of Health (SMoH), as well as international health agencies like UNICEF and WHO. The ICC is also included in this category. Bilaterals and international donors, whose interests can be broadly described as development focused, constituted 17% (n=5) of the network. Federal entities that play a financing role in the network, such as the Federal Executive Council, the FMoF, the MDG Office, the legislature and the state executives, made up 17% of the network. Notably, only one civil society/non-governmental organization (CSO/NGO) actor, a health professional association, is part of the network.

Vaccine programme implementation network
Similar to the vaccine introduction network, the decision-makers for programme implementation were predominately health sector focused; out of 15 actors, 10 (66%) were health related (data not shown). Only two international organizations were represented, both health agencies. The finance block for the network consisted of only two actors—the state and the local government executives. Yet again, only one CSO/NGO emerged as a member of this network.

Types of roles
To elucidate the different types of roles actors play in vaccine decisions, we asked respondents the type of interaction they had with other network members and whether or not that actor influenced their organization. We deduced three major types of actors. One set of actors are involved in the technical decision-making process, i.e. evidence generation, collection, evaluation (including disease burden and vaccine cost-effectiveness) and development of a business case for vaccine introduction, (including budgets and opportunity costs). This ‘technical core’ includes NPHCDA, Minister for Health, FMoH, international organizations like WHO and UNICEF, and local and international disease experts. A second group emerged—the ‘financial core’. These are actors that influence or control funding decisions about vaccine introductions. They include the Federal Executive Council, the legislature, Ministry of Finance and MDG Office. A third ‘implementation core’ of actors involved in the delivery and uptake of any new vaccines was defined. This group includes state and local governments, community-level actors and health care providers.

Relational ties
Vaccine introduction network
Figures 1a and 1b are social network maps showing the interrelationships of decision-makers that influence vaccine introduction. The number of ties to or from an actor indicates the number of other nodes with which the actor interacts.

Overall, the network appears centralized around three nodes, the NPHCDA, the Minister for Health and the ICC (Figures 1a and 1b). Total number of ties for each node ranged from 1 to 21 with a median of 3. The NPHCDA is the most central actor with a total of 21 ties in a 29-node network. This translates to linkage with 72% of the network members (Table 2).

The second most networked actor is the Minister for Health, with a total of 18 links to 62% of the network members. There is significant overlap in the egocentric networks of the NPHCDA and the Minister for Health. For example, 14/18 of the Minister’s connections are also connected to the NPHCDA, suggesting that both actors are interacting with the same stakeholders.

Other well-connected actors include the two international health agencies with eight and seven total ties respectively, and the ICC with five. The general pattern of networking observed was that the federal government health institutions had the most connections followed by the international health agencies, then the state government institutions. Less connected were the media, health providers, the federal government-financing block, the community and international donors, who were among the most peripheral in the network. It should be noted, however, that many of these international donors were not interviewed, thus the missing data is a potential source of bias.

Vaccine programme implementation network
For the most part, state-level actors drive programme implementation, although federal actors like the NPHCDA, the FMoH, and international health agencies were also represented and influential (Table 3 and Figure 2a). Nine of the 15 actors appear in both the introduction and implementation networks; these include the NPHCDA, SMoH, FMoH, community leaders, the community, international health agencies, providers, manufacturers and state executives.

Total ties for each actor in the implementation network ranged from 1 to 11 (Table 3, Figure 2b). The implementation network centres around two key nodes—the media and the SMoH—having 9 and 11 ties, respectively. All other members of the network had between one and five network connections; the local government players were moderately connected while the international health agencies had the fewest connections. Although the implementation network had fewer actors than the introduction network, the former had higher network density than the latter, suggesting relatively more interactions among the implementation network members (Table 4).

Perceived influence
Vaccine introduction influence network
We report on direction and magnitude of influence between two actors. Outdegree refers to the number of other actors citing the index actor as an influence when they interact, while indegree is the sum of other actors the index actor cites as a source of influence. Table 2 summarizes degrees for each actor. In addition to assessing the direction of influence between dyads in the network, we quantified the perceived level of influence each node had on the vaccine decision process. The size of the nodes reflects the highest influence score assigned by any network member from a range of 0–10, with 10 being

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Figure 1a  Interaction of actors involved in decision-making on vaccine introduction

Figure 1b  Interaction of actors involved in decision-making on vaccine introduction: ordered by centrality
the most influential. Average scores ranged from 1 to 10 with a median of 2 and a mean of 4.

About a quarter (7/29) of the network members at the federal level were perceived to be highly influential (average scores ≥8 points) (Table 4). The three most influential players as perceived by our study participants appear to be the NPHCD, the Minister for Health and the ICC with a score of 10 each. The NPHCD emerges as being influenced by the largest number of other actors, with an indegree of 19; similarly, with the largest outdegree of 13, the agency influences the most number of other actors. This is consistent with the quantitative measure of influence.

Table 2 Vaccine introduction decision-makers network: organizations involved and node-level statistics

<table>
<thead>
<tr>
<th>Type of organization (no. of respondents)</th>
<th>Actora</th>
<th>Total no. of ties</th>
<th>No. of nodes that actor influences (outdegrees)</th>
<th>No. of nodes that influence actor (indegrees)</th>
<th>Influence score (range: 0–10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Govt. of Nigeria</td>
<td>NPHCD</td>
<td>21</td>
<td>13</td>
<td>19</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>MoH</td>
<td>18</td>
<td>12</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>FMoH</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>ICC</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Other Federal Govt. bodies (5)</td>
<td>Legislature</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>MDG</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>FMoF</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>FEC</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>NAFDAC</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>International actors</td>
<td>Intl health agency 1</td>
<td>8</td>
<td>7</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Intl health agency 2</td>
<td>7</td>
<td>5</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Intl donor 1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Intl donor 2b</td>
<td>1</td>
<td>1</td>
<td>–</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Intl donor 3b</td>
<td>1</td>
<td>1</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Bilateral org 1b</td>
<td>1</td>
<td>1</td>
<td>–</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Bilateral org 2b</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Intl orgb</td>
<td>1</td>
<td>1</td>
<td>–</td>
<td>1</td>
</tr>
<tr>
<td>Individuals</td>
<td>International disease expertb</td>
<td>6</td>
<td>6</td>
<td>–</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Influential internationalb</td>
<td>2</td>
<td>2</td>
<td>–</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Local influential individualb</td>
<td>1</td>
<td>1</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td>End users</td>
<td>Local disease expertb</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>State Govt. (6)</td>
<td>State MoH</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>State Executive</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Community (3)</td>
<td>Community leader</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Community</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Care givers (4)</td>
<td>Providers</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Professional Health Association</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Informal actors</td>
<td>Media</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Manufacturers</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total (38)</td>
<td>122</td>
<td>85</td>
<td>87</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: aConceptually, the terms ‘node’ and ‘actor’ are used interchangeably. In this table, actor = index node.
bActors were cited by others as influential but were themselves not interviewed.

NPHCD = National Primary Health Care Development Agency; MoH = Minister for Health; FMoH = Federal Ministry of Health; MDG = Millennium Development Goal; FMoF = Federal Ministry of Finance; FEC = Federal Executive Council; NAFDAC = National Agency for Food & Drug Administration and Control; ICC = Inter-Agency Coordinating Committee; State MoH = State Ministry of Health.
The next set of influential actors was an international health sector donor and two international health agencies. With the exception of the health-focused international donor, there appears to be a correlation between centrality and perceived influence among the health sector actors. We see that highly networked actors were also perceived to have strong influence on the vaccine policy process.

The financial block and politicians, i.e. the MDG office, the Federal Executive Council, FMoH and legislators, were shown to have relatively few connections within the networks, but were perceived to wield a moderate level of influence on vaccine decisions. Surprisingly, relatively low influence was attributed to the state executives and two bilateral organizations that fund immunization programmes. Although one would expect the bilateral to appear more influential than our data suggest, because both are members of the ICC, and could channel their influence through that body, their low ranking may not reflect their full role in shaping the vaccine policy process.

Again, health care providers and the lone CSO/NGO in the network (a member of the child health community) were rated as low-influence actors. Given that these are two of the primary constituencies that make vaccine delivery to the child possible, the merits of involving them more in decision-making should be explored. The SMoH and community leaders were also perceived to have low influence on the process.

Vaccine programme implementation network
Nine out of 15 network members cited the media as a source of influence, making them the most frequently cited. In turn, the media cited three network members who influenced them. The SMoH reported being influenced by five network members; in turn they were cited by seven others as a source of influence on issues regarding programme implementation. Relatively more actors in this network were rated highly influential: about 40% compared with 24% in the introduction network (Table 4). The most influential actors were the NPHCDA, the SMoH, media, community leaders, health care providers and primary health care (PHC) centres. In contrast, all these actors (except the NPHCDA) were perceived to have low influence in the introduction network.

Discussion
Previous efforts to understand the drivers of NVI decision-making have characterized the political, epidemiological and economic variables that most clearly drive introduction decisions (Danovaro-Holliday et al. 2008; Lydon et al. 2008;
Figure 2a Interaction of actors involved in decision-making on vaccine programme implementation.

Figure 2b Interaction of actors involved in decision-making on vaccine programme implementation: ordered by centrality.
Shearer et al. 2010). The literature, thus far, illustrates the content of messaging, rather than the pathways by which those messages move to and from their intended targets. Even when relationships with decision-makers are cited as relevant factors, the precise nature of those relationships has not been characterized in detail (Hajjeh et al. 2010).

We employed SNA to describe the composition, interrelationships and perceived influence of vaccine decision-makers in Nigeria with the goal of understanding the policy-making process. Our study has four main findings. First, the network of policy makers (involved in decision-making about NVI) is diverse but highly centralized around two entities—the Minister for Health and the NPHCDA. Other stakeholders playing a role include governmental organizations, like the FMoF, the legislature, the MDG Office; international organizations, like WHO, UNICEF, GAVI, UK Department for International Development (DFID) and the Bill & Melinda Gates Foundation; state and local governments; non-governmental bodies; community leaders; the media and others.

It is important to differentiate the roles of the FMoH and that of the Minister for Health. On one hand, the FMoH’s role is technical; its Department of Health Planning, Research and Statistics collects, analyses, interprets and incorporates vaccine-related information into health planning. This is done in partnership with the NPHCDA. On the other hand, the Minister, who is a cabinet-level political appointee, plays multiple roles. He is a ‘gatekeeper’ for all FMoH activities, approving major decisions and actions. In addition, as chair of the ICC, he influences the unified stand of the international partners and government actors. Finally, he takes recommendations to the Federal Executive Council (The President, Cabinet Ministers and State Governors) where approval is given. He also leads advocacy among politicians and the legislature particularly. The combination of these roles makes the Minister for Health independently influential in vaccine introduction decision-making. The influence score for the FMoH diminishes to a mere ‘2’ once the Minister is excluded (data not shown).

The observed prominence and centrality of the FMoH-affiliated actors is expected given that vaccine programmes are the ministry’s responsibility. Although Nigeria’s health ministry drives the vaccine policy, it is not the only group needed to assure the success of NVI. Our qualitative interviews identified three functional cores of decision-makers: the technical core (Minister for Health, NPHCDA, FMoH and international health agencies), the financial core (FMoF, Federal Executive Council, legislature and MDG committee) and the implementation core (the state and local governments, SMoH and health providers). Among these, the technical core emerged as the most central and influential.

The second main finding was that the two groups of stakeholders who are critical to making financing decisions and driving programme implementation were not well connected in the network, and in the case of the implementation actors, were also perceived to have low influence on the policy process. For example, the FMoF was located at the periphery of the network and may therefore be removed from the exchange of information that could facilitate their decisions to expand the FMoH’s budget for new vaccines. Comparing our findings with those of Conway et al. (2008) in Mexico and Mauritania, the only other study that employed SNA to examine vaccine policy processes, we note that while the Mexican and Mauritanian networks appeared more densely connected than the Nigerian network, the FMoF appeared at the periphery of the decision-making process in all three countries. Toikka (2009) suggests that the network position of actors is associated with the number of policy outputs and decisions; perhaps closer integration of the financial players in vaccine decision-making process may result in quicker funding decisions on NVI.

Similarly, the implementation core (state and local governments, SMoH, communities and health care providers), who are key to delivering vaccines by implementing policy decisions, appear to be only marginally engaged in decision-making. In the last several years, Nigeria has faced considerable challenges with delivering routine immunizations (UNICEF and World Health Organization 2010), and although recent data show some improvement (National Immunization Coverage Survey 2010, unpublished survey), there is still much that needs to be done. Integrating the state and local government actors into the policy process earlier could improve implementation. Engaging states in the decision-making around NVI may motivate them to improve service delivery and mobilize communities around new vaccines.

Our third main finding is that all international donors appear peripheral and minimally influential, with the exception of one health sector donor who was perceived as highly influential but observed to have only one connection in the network. We interpret this finding with caution because not all donors mentioned were themselves interviewed; therefore, there is a potential for bias. The direction of bias for a donor’s connectedness will be to underestimate it due to missing data; for influence, the bias could be in either direction. While we cannot definitely infer donors’ connections and influence due to missing data, it is worth noting that a number of these donors belong to the ICC. The ICC plays the co-ordination role in immunization programmes in Nigeria and our data show them to be both well connected and highly influential. To the extent that these donors could exert their input via the ICC, their net individual influence could be higher than observed.

Finally, we found that community leaders, civil society organizations, the media and the manufacturers play a minimal role in influencing vaccine decisions and were peripheral to the process. The recent experience with polio in northern Nigeria demonstrates the significant social influence of religious and traditional leaders. Traditional rulers enjoy popular support in

<table>
<thead>
<tr>
<th>Network statistic</th>
<th>National</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order</td>
<td>29</td>
<td>15</td>
</tr>
<tr>
<td>Size</td>
<td>122</td>
<td>56</td>
</tr>
<tr>
<td>Density</td>
<td>0.21</td>
<td>0.29</td>
</tr>
<tr>
<td>% of nodes scoring ≥ 8 points on influence</td>
<td>24</td>
<td>40</td>
</tr>
</tbody>
</table>

Notes: Definition of statistics: order = number of nodes; size = the number of non-zero ties; network density = size relative to the number of possible ties for directed networks; more generally, the means strength of a tie.
Nigeria, particularly in the north where Islam is a strong influence and the religious and traditional leaders are practically indistinguishable. Their influence comes from the allegiance communities have for the institutions they represent—religious, traditional or ethnic. In addition, traditional rulers are seen to be more responsive than politicians to the plight of individuals, showing greater commitment to the harmony of their communities (Blench et al. 2006). Although not all traditional leaders enjoy such support and respect, as an institution they can aid health programme managers in mobilizing communities and raising public support for immunization. Vaccine programmes can benefit from engaging religious leaders in discussions about the needs of their community and how to best meet them. These leaders should also be equipped with information; seminars and training may help them perform as an information bridge to the community.

Limitations
One limitation of our study is the small sample size. Caution is therefore warranted in interpreting the data as they may not be representative. However, because we drew respondents from the majority of institutions that would be involved in vaccine decision-making, our findings are likely to be qualitatively robust with regards to the sampled institutions.

Again, the network boundaries for vaccine policy-makers are unclear, constituting another limitation. We therefore employed snowball sampling to recruit respondents (Doreian and Woodard 1992; Lewis 2009). This method has the potential to miss some targets and introduce selection bias. To minimize this risk, we used a fairly broad definition for the boundary (Wasserman and Faust 1994): persons ‘involved’ or ‘influential’ in the decision to introduce pentavalent vaccine in Nigeria. The decision to introduce pentavalent vaccine was a concrete event that respondents could use as a frame of reference in deciding whom to nominate. We also began the snowballing with a diverse set of respondents to obtain a good spread of nominations. There may still be some gaps as, for example, only one CSO was identified as involved in the network. This small number may be because CSOs are not (or recognized not to be) engaged in the process; or because our sampling missed them.

Another caution in our data is that we measured perceptions of influence but people’s perceptions may differ from reality. Finally, we did not interview some of the actors represented in the network, which may lead our findings to underestimate the network density, mask connections, distort the network position of some actors or bias estimates of influence downwards. For example, we did not interview some of the international bodies; if we did, they may have nominated other actors not represented on the map, and they may appear more central and more or less influential. On the other hand, the most central actors—the Minister for Health and NPHCDA, with the maximum influence scores—currently have ties with most actors we could not interview; therefore, the inference about their centrality or influence is unlikely to change with the full data.

Policy implications
Our study has important policy implications for NVI in Nigeria and for the use of SNA as a tool to improve vaccine policy processes. Because the addition of a new vaccine depends on achieving technical consensus, sustainable financing and programme capacity to deliver these vaccines, SNA of the key decision-makers can help shape policy and programmatic strategies to deploy information, influence or advocacy to the actors whose engagement and action can facilitate new vaccine introduction. In the Nigerian context, our findings suggest that the actors responsible for financial decisions and programme implementation could be integrated more closely into the decision-making process. Efforts to foster interactions and exchange among, and advocacy to, specific policy makers may strengthen decision-making by optimizing the influence and resources from all network members, ultimately accelerating vaccine adoption. In contexts where these other determinants are in place, and where individuals or organizations are identified as being the barrier to consensus, results of SNA could help to identify critical actors who may block or facilitate decision-making.

Finally, countries can use SNA to evaluate their policy processes for overt and covert sources of influence. Perceptions of who is driving vaccine policies may have consequences for the acceptability of vaccines by the public or specific interest groups. Influence networks revealed by SNA can shed some light on who is actually driving the decision-making, which when revealed may foster faster adoption of new vaccines consistent with a country’s priority.

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Conflict of interest
None declared.

Endnotes
1 Presentation at Global Meeting on Implementing New and Under-utilized Vaccines, Montreux, Switzerland, 22 June 2011.
2 The ICC is chaired by the Federal Minister for Health and comprises NPHCDA, WHO, UNICEF, USAID, Rotary International (Polio Plus), Department for International Development (DFID),...
European Union (EU), Association of Local Governments of Nigeria (ALGON), Embassy of Japan, Embassy of Canada, Embassy of Norway, World Bank, Médecins sans Frontières, Christian Association of Nigeria (CHAN), Red Cross, Coca Cola Nigeria, MDG office and Planning Department of the Federal Ministry of Health.

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