

NIGERIA

**Expanding Use of Magnesium Sulfate for
Treatment of Pre-eclampsia and Eclampsia**

Building Towards Scale in Nigeria



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I. Introduction

Pre-eclampsia/eclampsia is a serious condition that can develop during pregnancy, even in women with no risk factors. Although there is little understanding of what causes pre-eclampsia/eclampsia, there is an effective treatment for this condition which, if left untreated, can progress to coma and death. In 1994, the World Health Organization (WHO) recommended magnesium sulfate as the standard treatment for pre-eclampsia and eclampsia and within two years it was placed on WHO's Essential Medicines List. Despite its known efficacy, this inexpensive drug is often underutilized, in part because the diffusion of innovation takes time but also because of the service delivery challenges inherent to the use of magnesium sulfate—it requires a strong and effective referral system, often a challenge in under-resourced health systems. The underutilization of magnesium sulfate has been a recognized problem in Nigeria for some time; prior to 2007 there was almost no magnesium sulfate in the country.¹

The significant contribution of pre-eclampsia/eclampsia to maternal mortality in Nigeria—along with the promise of magnesium sulfate as a solution—caught the attention of the John D. and Catherine T. MacArthur Foundation in 2005 when a program officer overheard a conversation between two Nigerian doctors who were lamenting the failure of a piece of equipment in their hospital laboratory that was used for manufacturing magnesium sulfate. Without it, one was saying to the other, they would have no supply of the drug to treat pre-eclampsia/eclampsia and no way to save women's lives. The Foundation decided to fund a series of grants to expand the use of magnesium sulfate for pre-eclampsia/eclampsia in Nigeria and, in 2014, commissioned an evaluation of that work. This case study describes the findings of the evaluation, including the challenges encountered while implementing the projects, the successes achieved, and existing opportunities for future scaling up of the services across the country.

II. The Evaluation Process

In 2014, the MacArthur Foundation commissioned the Public Health Institute to conduct a process evaluation of the grants the Foundation had made to expand the use of magnesium sulfate as a treatment for pre-eclampsia/eclampsia in Nigeria. The purpose of the evaluation was to gain a deeper understanding of how these programs were implemented, where they were successful, and where they still face obstacles to scale up. A team of experts conducted a desk review of literature and grantee reports, interviewed global experts and local key informants and stakeholders (see Appendix A), and visited the program sites. Most of the data was gathered using qualitative methodologies: interviews with key stakeholders and evaluator observations during site-visits. In addition, available quantitative data was reviewed, with a focus on training records and hospital and health center service statistics gathered by grantees. The evaluation was carried out between June and November 2014.

III. Background

Magnesium Sulfate for Pre-eclampsia and Eclampsia—A Simple But Challenging Treatment

Pre-eclampsia is a pregnancy complication that results when a woman develops high blood pressure and an excess of protein in the urine after the 20th week of pregnancy (it is most common after the 32nd week). Left untreated, pre-eclampsia progresses to eclampsia, a condition of severe convulsions and sometimes coma. There is no way to predict who will develop the condition during pregnancy, but some women are at higher risk: women who are having their first pregnancy; women younger than 20 and older than 35 years; and women pregnant with multiples (e.g., twins). Identification of high-risk women is key to early treatment and overall reduction of maternal mortality and morbidity, particularly in low-resource settings.^{2,3} Treatment of pre-eclampsia with magnesium sulfate has been shown to significantly lower the risk of eclampsia (by 58%) and the risk of mortality (by 45%).⁴⁻⁶ The treatment has a very low incidence of severe side effects and mortality attributable to the drug is extremely rare (0.01%).^{2,7} With treatment, the symptoms of the condition are temporarily relieved though the health risk remains (the only cure for eclampsia is to deliver the pregnancy). In fact, the initial treatment is often so effective at quickly relieving symptoms that many women (and even some providers) mistakenly think that the problem has been solved.

From the patient's perspective, there is little warning before the onset of symptoms. This is especially true for women who have limited access to antenatal care and therefore do not have their blood pressure monitored. By the time a woman starts experiencing noticeable symptoms, such as vomiting, gastric pain, and headaches, the condition has progressed to a point where she requires immediate medical attention. If the woman knows to seek treatment and if she can get to a facility where treatment is available, the condition can often be managed for long enough to provide emergency delivery care. If she does not get care, she and the fetus will most likely die.

From the provider's perspective, treating pre-eclampsia or eclampsia using magnesium sulfate requires training and attention to detail. The drug must be mixed into solution using a specific dosing algorithm just prior to use (once prepared it remains stable only for 24 hours), and overdosing can be a concern. The first "loading" dose is large, often resulting in discomfort to the woman. Subsequent doses also need to be carefully measured and timed, adding to the clinical complexity of treatment. And, decision making regarding the progression of treatment through delivery requires good clinical judgment to properly assess the severity of the condition against the maturity of the fetus.

From a health systems perspective, providing magnesium sulfate involves, at minimum, ensuring its ready availability in the drug supply system (along with needed injection and intravenous supplies), staffing hospitals with trained providers, sensitizing women and their families to the signs of pre-eclampsia and eclampsia and need to seek care, and ensuring an adequate referral system from the primary healthcare level to hospital-based care. Ideally, services would also include the ability to provide the loading dose at the primary healthcare level with referral for continued treatment.

In summary, while the solution to treating eclampsia seems simple—get magnesium sulfate into the woman’s blood stream and deliver the fetus as soon as possible—doing so in time and correctly is complicated and involves many steps and many players.⁸

The MacArthur Foundation’s Funding Initiative—Grant-making for Alliance and Action

The initial conversation that sparked the MacArthur Foundation’s interest in solving the problems of magnesium sulfate use in Nigeria brought to light the challenge that two doctors faced in accessing a supply of the product for use in their hospital after their compounding equipment broke down. While fixing the broken piece of equipment would have been an immediate solution to that problem, the Foundation recognized the need for a more sustainable and comprehensive solution to the problem of drug supply. As a first step, the Foundation made a grant to Oxford University which convened a meeting of major stakeholders, including a leading pharmaceutical firm in Nigeria, to generate interest in the provision of magnesium sulfate; that firm went on to become the major supplier of the drug to Nigeria and other governments. The Foundation also recognized that drug supply alone would not guarantee successful access; coordinated and sustained efforts would be needed to support the entire complement of healthcare services necessary to provide the drug to the women who needed it. As a result of this broader perspective, the Foundation supported myriad activities including: constituency building; public advocacy; research and evaluation; and community outreach and capacity building, in addition to efforts to address product supply (see Figure 1).

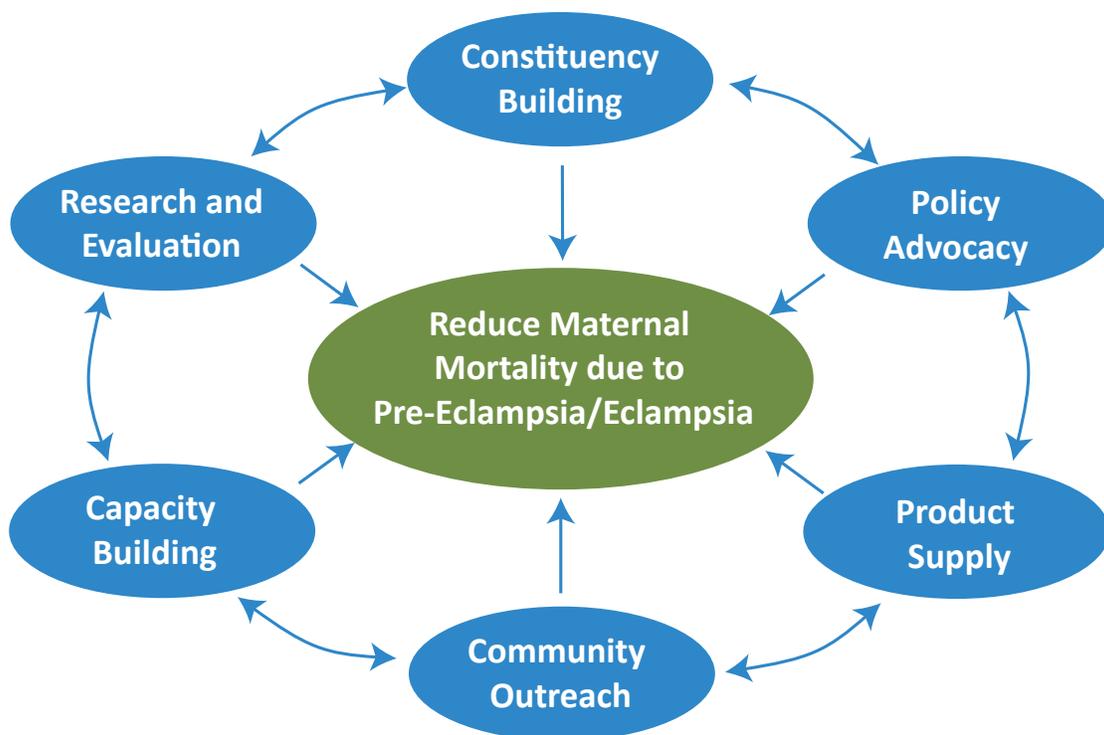


Figure 1. Interrelated strategies for expanding use of magnesium sulfate in Nigeria

In addition, fully aware of the difficulties in taking a good idea to scale in a country already challenged by an overtaxed health infrastructure (see box, The Challenge of Scale Up, below), the Foundation designed its approach with the following key elements of successful scale up in mind:

- Creating a vision and broad strategy;
- Legitimizing the approach;
- Building a constituency;
- Realigning and mobilizing resources;
- Modifying organizational structures;
- Coordinating action;
- Monitoring performance.⁹

The Challenge of Scale Up

A significant challenge for any health system is to bring successful pilot projects to national scale and sustain innovations. While it is often assumed that scale up will easily follow a successful pilot, the realities surrounding pilot project implementation (significant funding, strengthened infrastructure in the pilot project site) are very different from the realities faced by health systems managers as they try to expand the model (limited funding, competing health priorities, weak infrastructure). The average time for taking a successful pilot to national scale is 15 years.⁹

Research suggests that, to have the best chance of being widely adopted, innovations must be:

- A relevant solution to an important, perceived problem;
- An improvement over existing practices;
- Supported by evidence and, ideally, endorsed by credible sources;
- Observable so that potential users can see the results in practice;
- Easy to transfer and adopt;
- Compatible with the system's established values, norms, and facilities; and
- Able to be tested for feasibility before committing the potential user to full scale up.

All of these conditions clearly apply to magnesium sulfate as an intervention to address the problem of pre-eclampsia/eclampsia in Nigeria, thereby providing a strong foundation for successful scale up.

IV. Projects Funded and Activities Implemented

Beginning in 2007, the MacArthur Foundation made a series of grants to both public (Federal Ministry of Health) and private organizations (Population Council, Society of Gynecology and Obstetrics of Nigeria, EngenderHealth, and Ipas) to integrate the use of magnesium sulfate into the Nigerian health system. The grantees (with the exception of Ipas which started its work later) worked synergistically and carried out concurrent activities that addressed product supply, tested and evaluated new protocols, expanded the model, and built capacity.

Addressing supply issues

It was generally believed that the biggest issue in Nigeria around magnesium sulfate was the persistent unavailability of the drug. Stakeholders cited two reasons for this problem: the lack of profitability of making the drug and the inability of the government medical stores logistics systems to keep it in good supply. In addition to the supply issues, historically there had been little demand for the drug due to the complexity of dosing, including the provider fear of toxicity with overdose.

In 2007, the MacArthur Foundation brought together stakeholders from the Federal Ministry of Health and UNICEF to focus on the supply of magnesium sulfate in the country. The initial plan was to use the well-established and secure UNICEF supply chain to address supply and distribution issues, with recognition that ultimately state governments needed to put in place good and sustained procurement, supply, and tracking policies to avoid stockouts and pilferages. The Population Council purchased the drug for the initial pilot activities (with funds from the MacArthur Foundation) and the Federal Ministry of Health followed this with a large purchase (900,000 doses) to ensure that all 36 states and the Federal Capital Territory (Abuja) were included in the national scale up plan (also with support from the Foundation).

Research and evaluation

In 2008, the MacArthur Foundation funded the Population Council to carry out an introductory pilot project in Kano State in northern Nigeria; doctors and midwives from ten state health facilities were trained to use a simplified protocol (modified Pritchard regimen) to administer magnesium sulfate. In addition, the project conducted community sensitization efforts focused on helping women and their families identify the signs and symptoms of pre-eclampsia and worked with community health extension workers and traditional birth attendants to address the need for recognition of the danger signs, treatment, and referral. The project demonstrated a significant drop in the case fatality rate due to eclampsia—from 20.9% before the start of services to 2.3% after—and there was no significant difference in the cost of using magnesium sulfate over the standard treatment of diazepam.¹⁰ The significant drop in mortality and the cost effectiveness of the magnesium sulfate intervention encouraged the Kano State government to scale up the intervention to the remaining 26 hospitals in the state.¹⁰ The Population Council produced a national curriculum for the use of magnesium sulfate to treat pre-eclampsia and eclampsia as part of this early work.

Expansion of the model

As a result of the compelling evidence from Kano, the MacArthur Foundation provided additional support to the Society of Obstetrics and Gynecology of Nigeria (SOGON) to expand the magnesium sulfate work to six states (Kano, Plateau, Enugu, Borno, Cross River, and Lagos) with the introduction of the drug in one hospital in each state. The focus of the SOGON work was to draw attention to magnesium sulfate as a proven medical intervention and to strengthen policies and provider capabilities to make treatment with magnesium sulfate more widely available. SOGON engaged at the state government level to raise awareness and advocate for state policies, using its members to visit health officials throughout each of the designated states. Beyond its work with clinicians and the health system, SOGON provided public health education on issues relating to obstetrical emergency care in the project states. Once again, the significant case fatality drop (from 15.1% to 2.7%) across the six state hospitals lent local legitimacy to the use of the drug to treat pre-eclampsia and eclampsia.¹¹ The snowball effect from these results allowed for the scale up and expansion of magnesium sulfate into other states.

Capacity building

A grant made to the Federal Ministry of Health in 2008 enabled the Federal Ministry of Health to focus on institutionalizing delivery of magnesium sulfate throughout the healthcare system, building on the trainings that were already occurring as part of that institution's Integrated Maternal, Newborn, and Child Health initiative. The Ministry allied itself with the Nigerian Medical Association and the National Association of Nigerian Nurses and Midwives, as well as with Obstetrics and Gynecology department heads and chief pharmacists of selected tertiary health institutions in each state to integrate magnesium sulfate into existing clinical services. They also conducted trainings, both in-service and pre-service, in 170 institutions across all 36 state and the Federal Capital Territory; through a process of step-down trainings, approximately 1,818 doctors were trained. Figure 2 shows the incremental process to scale up of services.

As the expansion progressed, it became clear that efforts to initiate treatment at the primary care level were also needed; by the time women reached the hospital, the condition had often progressed past the point of effective treatment. A continuing grant to the Population Council in 2011 enabled focused attention at the primary healthcare and community levels to assess how best to involve traditional birth attendants, community health extension workers, and nurses in identification, immediate clinical care, and referral. The Population Council conducted operations research in 20 primary care facilities—10 with a task-shifting intervention and 10 without

Figure 2. The expansion of magnesium sulfate for treatment of pre-eclampsia and eclampsia in Nigeria



Year	2008	2009	2010*
States	1	11	36
Hospitals	10 (then 36)	48	400+
Staff trained	185	100's	1000's

*Note: Although all states have received some level of training, the progress to scale up of services ranges from only training in some states to integration into multiple hospitals in others.

the intervention. By documenting the need for and advocating for policy and protocol changes, the Population Council gained approval for task-shifting to community health extension workers so that the initial loading dose could be provided at the primary healthcare level. The work also involved ethnographic research to determine the factors influencing the observed delay in women seeking treatment and to develop ways to facilitate more successful referral for further care.

The MacArthur Foundation has continued to find ways to integrate magnesium sulfate into ongoing work and build capacity. For example, Ipas received support in 2013 to train medical interns about comprehensive maternal care; the training integrates information about the key causes of maternal mortality and trains medical interns to correctly use various effective interventions, including magnesium sulfate for pre-eclampsia and eclampsia.

V. Evaluation Findings: Successes and Remaining Challenges

In the whole of Kano state, prior to this project there was only one doctor at Murtala Muhammad Specialist Hospital who occasionally used magnesium sulfate to treat eclampsia when he was on shift and the drug was in stock. Consequently there was high mortality from eclampsia, with a case fatality rate of around 18.5% and accounting for close to 40% of maternal mortality in the state. However this significantly changed with the coming of the project. The case fatality rate from eclampsia is now around 2–3% and mortality from other maternal causes has now overtaken eclampsia. And all these resulted from a simple training of one and a half days.

—Consultant at Amino Kano Teaching Hospital

By successfully implementing the Foundation’s multi-faceted strategy and paying attention to the necessary steps in the scale up process, grantees have collectively made significant progress towards the full integration of the use of magnesium sulfate into the Nigerian healthcare system. Figure 3 provides an overview of how the specific approaches used by grantees aligned with the recommended steps for scale up.⁹

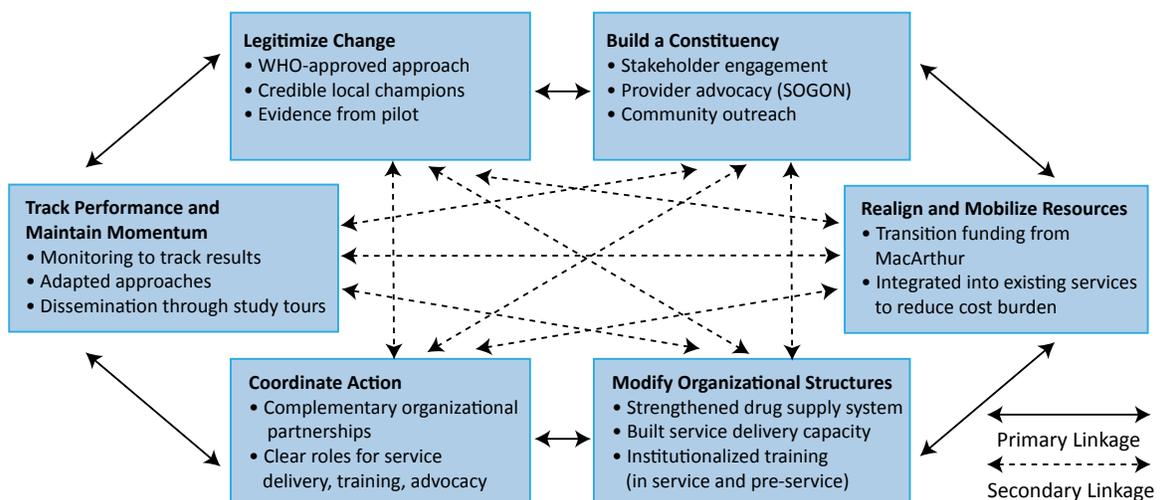


Figure 3. Alignment of project approaches with steps in the scale up process

Notable achievements in the process to scale up the use of magnesium sulfate in Nigeria, as captured from discussions with key stakeholders and informants, include:

- The use of the drug was legitimized and integrated through the effective use of research and evaluation;
- Stakeholders were engaged, support from and action by other organizations was galvanized, and a national constituency was built;
- Tasks were shifted to include community health extension workers;
- Financial resources were realigned and mobilized;
- National guidelines and curricula were created and implemented, and the referral system and patient compliance with referrals were bolstered; and
- Drug supply channels were strengthened and systems put in place to monitor the distribution system.

Research successfully generated evidence

Documenting and proving the utility and success of magnesium sulfate was instrumental to legitimizing its use and ensuring the continued engagement of health ministries and institutions. The rigorous research led by the Population Council helped to seat the work within wider international evidence on the topic and helped stakeholders: 1) realize and understand the dynamics of the complexities of administering the correct doses of magnesium sulfate; and 2) recognize that midwives, nurses, and community health extension workers could safely administer the loading dose of the drug and then provide accurate referral information and action.

Remaining challenges—More operations research is needed to continue to scale up the program and overcome obstacles to full implementation. For example, it was reported that the quality of the clinical services needs to be improved. The correct use of magnesium sulfate is very inconsistent and there is the need to address the underlying factors that prevent health workers from providing magnesium sulfate according to acceptable standards, including:

- Resistance to change from what the providers are used to, complicated by the fact that the protocol for the administration of magnesium sulfate is much more cumbersome than that of diazepam (the previously used but less effective drug for pre-eclampsia and eclampsia);
- Inadequate number of trained staff as a result of transfers, retirements, and attrition; and
- Failure to follow the protocol to refer and/or deliver the woman of her pregnancy (sometimes even sending her home), mainly due to the misperception that the loading dose of magnesium sulfate—which effectively stops convulsions—has treated the problem.

Stakeholders were engaged and a constituency was built

Diligent engagement with the government at every step of the program ensured the sustained attention of state officials, as well as medical and nursing successes with the drug, which helped to achieve the necessary support, including at top levels of the government. The role played by the Society of Gynecology and Obstetrics of Nigeria (SOGON) was judged by key informants as particularly

important in legitimizing the intervention and gaining acceptance of the project by government officials at the national level; SOGON members and other health professionals engaged by them became the loudest advocates of magnesium sulfate to the government.

Medical and health practitioners, initially the biggest obstacle to the introduction of these technologies and interventions, turned out to be its biggest advocates once they were convinced. This turned out to be the most important outcome of advocacy and it led the government's speedy acceptance of the interventions.

—Key informant

At the state level, the project cultivated champions within the Obstetrics and Gynecology community to spur local action needed to introduce and sustain a robust level of effort with magnesium sulfate. For instance, oft-mentioned by respondents was the leadership of the then Director General of Kano State Health Services Management Board, who helped galvanize the state government's interest in magnesium sulfate.

The Director of the State Health Services cancels every other appointment to attend and make sure he addresses any issue related to magnesium sulfate brought to him. Certainly without his leadership and support the introduction of magnesium sulfate would not have been so successful.

—Key informant

Remaining challenge—Continuing the advocacy and engagement with policymakers as well as with new medical and nursing staff is critical to build on the achievements and maintain the momentum that has been gained. The full integration of magnesium sulfate into the curricula and standards of care in Nigeria is new and still very vulnerable as is documented by the following:

Within just few months of its introduction, mortality from eclampsia fell to zero in all intervention facilities. However after December 2005, mortality from eclampsia returned to its pre-pilot period in all the facilities. It was then we realized how important advocacy is to the introduction of a drug or service, no matter how good it is. If we had done good advocacy, the government would have taken over and we may not have had a return to the pre-magnesium sulfate period in terms of mortality from eclampsia in those facilities.

—Key informant

Tasks were shifted to include community health extension workers

One element of successful scale up is the modification of existing organizational structures to achieve the desired outcome. A key outcome of the program was the operations research that demonstrated successful task shifting to include the community health extension workers in the administration of the treatment protocol. The Population Council's research at the hospital and community level revealed that the women in need of the life-saving drug resided mostly in rural areas, prompting a pilot study and program to train community health extension workers to administer the first loading dose and then refer the patient. The results of that study led to a change in national health policies to now allow community health extension workers to administer the drug and refer cases for continued care. This proved critical to addressing better the needs of rural women:

The task-shifting aspects of the effort have been most important, especially in the North of Nigeria where it is especially difficult for women to access health services.

—Key informant

Remaining challenges—The evaluation identified two significant problems with the referral system:

- Referral from primary healthcare facilities to magnesium sulfate intervention sites was not timely, resulting in women dying at the referral site (it was noted that most fatal cases of eclampsia were those referred from the primary healthcare level). Since most primary healthcare facilities have not benefited from the intervention and scale up efforts, major problems remain in terms of timing and effectiveness of referral from these locations; and
- Many patients who received a loading dose failed to complete the referral process to a higher level facility for delivery; in one study, 90% of women who received the loading dose did not complete the referral process.¹² Because of a sense of immediate relief and the belief that the worst was over, some patients did not comply with referral instructions to get further care. And even those that did get to the referral level facilities often failed to understand that the loading dose only stabilized them and they were still at risk; providers reported that the rapid resolution of symptoms provided by the loading dose often resulted in patients asking to be discharged home. These failures to adhere to the referral process, by both the women and providers, account for some of the deaths seen in the program.¹²

There is an ongoing need for community-based education on the symptoms of pre-eclampsia/eclampsia as well as need for medical care even beyond the initial relief of the loading dose of magnesium sulfate. The rates of institutional births and births attended by a skilled birth attendant are still low throughout Nigeria and especially in the north. From the perspectives of the healthcare workers interviewed, the lack of community sensitization and awareness significantly affected their interventions with magnesium sulfate. The role of community education and sensitization was acutely noted as important to remedy delays in care.

National guidelines, curricula, and job aides were created

One hallmark success of the magnesium sulfate introduction work was the development of national service delivery guidelines and training curricula for the use of magnesium sulfate to treat pre-eclampsia and eclampsia and their subsequent integration into the national healthcare system. The development of a clear protocol (including guidelines and algorithms for the administration of magnesium sulfate) for training of all levels of service providers, including community health extension workers, was a collaborative effort between the Federal Ministry of Health, EngenderHealth, the Population Council, SOGON, State Health Commissioners, and other partner organizations. With the assistance of state-level actors and community stakeholders, these efforts permeated down to Local Government Areas, including at the health facility and community levels. Job aides helped to solidify correct practice:

Knowledge has been imparted. The algorithms provided to each provider were helpful in guiding treatment and in providing on the job training to new providers

—Key informant

Remaining challenge—Continued monitoring is important to make sure that the new guidelines and curricula are included in the training of all new healthcare workers. As proved to be the case with stakeholder engagement, the achievements of the initiative could easily be lost if attention is not paid to enforcing the new guidelines. It will be important to continue this advocacy for many years, until the curricula is viewed as integral to medical and nursing training.

Partners have begun to address drug supply issues

Working closely with the Federal Ministry of Health and partners, the project has begun to address problems with the supply of magnesium sulfate. In the beginning, grantees reported frequent stockouts of magnesium sulfate and other needed supplies such as urinalysis strips and sphygmomanometers. To address this supply problem the Population Council increased the focus on effective monitoring, requisitioning, and distribution of drugs at program facilities.

Key informants noted that the enhanced monitoring of magnesium sulfate supplies had a positive effect on reducing stockouts not only of magnesium sulfate but of other medicines as well.¹³ And in Kano state, the increased focus on effective monitoring, requisitioning, and distribution of drugs at engaged facilities and at the administrative level was believed to have positively affected other aspects of the health system.

It [the project] built confidence in the health system. There was obvious boost in the morale of health workers and consequent increase in the confidence they have in the health system... there was obvious decrease in mortality and morbidity and health workers themselves saw firsthand the wonders of magnesium sulfate with evidence and therefore became some of its most important advocates.

—Maternal and Child Health Coordinator in Kano State

Remaining challenges—Much still needs to be done to strengthen drug supply channels as there are frequent stockouts of magnesium sulfate throughout the country. Other supplies and equipment critical for the management of patients with pre-eclampsia and eclampsia, such as urinalysis strips and sphygmomanometers, are also often not available or dysfunctional. In Kano State, these commodities are supplied as part of the Kano State Free Medical Services Scheme. Most respondents did not freely admit to lack of magnesium sulfate in the facilities where they work. However, every service provider interviewed maintained that the reason magnesium sulfate supply was never exhausted at the general hospitals was because health workers in the hospitals would only provide the loading dose of the drug, requiring patients to purchase the additional doses needed for treatment from the private sector (magnesium sulfate appears to be readily available through hospital pharmacies). (Note: according to one study conducted in 2013, 62.2% of the cases required families of the women to purchase the drug for use after the loading dose.)¹²

For any eclamptic woman brought to our facility, we provide only the loading dose free. If she requires maintenance she has to purchase from outside the hospital. If we provide 100% of doses required by every eclampsia patient, the supply will not be enough for us.

—Matron in labor room, Kano

VI. Recommendations for Moving Forward

Nigeria is well on its way to fully integrating the use of magnesium sulfate in its maternal health services. The impressive work that has been done needs to be sustained and numerous obstacles overcome if true scale is to be achieved. Recommended actions to address remaining challenges include:

- Ensure continuum of care from home to hospital;
- Adopt targeted social and behavior change strategies to increase hospital births;
- Improve public sector supply and logistics system for magnesium sulfate; and
- Focus on integration of services.

Ensure continuum of care from home to hospital

Community-based advocacy and engagement of community leaders, counsellors, and health workers for education about the signs and symptoms of pre-eclampsia is very important if treatment using magnesium sulfate is to be effective. In addition, an effective referral system is crucial because the first part of the treatment—the loading dose—only buys time and does not resolve the problem. Most providers interviewed noted that the eclampsia mortality seen in the hospitals largely comes from cases referred from Primary Health Centers, located in the communities. Practical ways to improve the effectiveness of home to hospital continuum of care include:

- Help households identify the danger signs of pregnancy and understand need for referral through trainings of community resource persons (such as traditional birth attendants) and by involving women's advocacy groups in the community;
- Capitalize on the recent policy changes on task-shifting to devolve the administration of the loading dose of magnesium sulfate to the community health extension workers at Primary Health Centers;
- Help communities solve their referral transport challenges;
- Improve the quality of antenatal care services by ensuring that needed supplies are available and developing a checklist that will help improve the detection of pre-eclampsia at antenatal care visits; and
- Improve the quality of the care women receive in the health facilities so they will trust the services and not avoid using them.

Adopt targeted social and behavior change strategies to increase hospital births

The high frequency of home-based births in Nigeria makes preventable causes of death like eclampsia very devastating and difficult to control. Because the full regimen of magnesium sulfate must be completed at the hospital level, channels must be explored to ensure that women at risk are detected early and moved to hospital. Eventually ways to encourage and ensure hospital delivery in all the regions of the country—rural or urban—must be pursued. A model that recognizes the pregnant woman as a consumer who will make choices based on personal, societal, and structural influences can help identify barriers and suggest possible interventions. Enlisting the support of women's advocacy groups to

generate demand for quality maternal health services while improving the quality of the interpersonal care provided in facilities will help build trust in the delivery services. A mistrust of health services, and of hospitals in particular, poses an almost insurmountable barrier to reducing the risk of eclampsia. Generating a public demand for woman-friendly delivery services is an approach that could be conducive in Nigeria, given the predominance and strength of women's advocacy groups in the country.

Improve public sector supply and logistics system for magnesium sulfate

Ensuring a consistent and adequate supply of magnesium sulfate continues to be a significant challenge. The general state of the government's free maternal health medical services program—which was designed to improve access to health services including essential health commodities—was frequently mentioned by respondents as a key reason why the government's magnesium sulfate scale up has not been fully realized. This is because the supply of magnesium sulfate as part of the free medical services is now being affected by the irregularity of the free medical supplies. To compound the situation, healthcare workers reported being afraid to inform patients that there are no commodities available for fear of being accused of sabotaging the government.

While magnesium sulfate is readily available in the private sector, health workers in the public sector have created their own solution to the supply problem—all facilities visited reported providing only the loading dose because of inadequacy of supply. In order to ensure the sustainability of national scale up of magnesium sulfate, the public supply and distribution channels must be stocked and monitored. This can be achieved through strategic policy and advocacy work with the National Primary Health Care Development Agency and its state counterparts and is feasible given the expected increase in funding for Primary Health Care through the National Health Act, the proposed Village Health Worker program, and the new focus by major donors (including the Gates Foundation) on strengthening primary healthcare services.

Focus on integration and coordination

The next phase of work to fully scale up the use of magnesium sulfate for the treatment of pre-eclampsia and eclampsia in Nigeria, will need to focus on integrating the services within all the levels of the healthcare system:

National level—Close integration with the efforts of the National Primary Health Care Development Agency (NPHCDA) and its maternal health programs (chiefly the Midwives Service Scheme and the Subsidy Reinvestment and Empowerment Program—Maternal Child Health, but also with new programs including the Village Health Worker program). NPHCDA will have funding from the National Health Act and will likely be a central actor with an anticipated grant for primary healthcare strengthening from the Bill and Melinda Gates Foundation.

State level and Local Government Areas—While state Ministries of Health are necessary for the adoption of policies and guidelines at the secondary level, the state Primary Health Care Development Agencies, the Ministry of Local Government and Chieftaincy Affairs, and the respective local government authorities have significant operational roles to play at the primary healthcare level.

Community level—Collaborating with local advocacy organizations that have specific community engagement strategies such as PLAN and the Federation of Muslim Women Association of Nigeria will be important.

Training institutions—While work with the regulatory agencies at the national level and selected training institutions has provided evidence of workability, there is critical need to institutionalize the training curriculum and activities on magnesium sulfate at the institutions that train midwives and community health extension workers.

Finally, many organizations, both local and international, are now working in Nigeria to improve maternal health services, including the provision of magnesium sulfate for eclampsia and pre-eclampsia, increasing the need for effective collaboration and coordination.

VII. Conclusion

The effort to scale up use of magnesium sulfate in the Nigeria health service delivery system to address the problem of pre-eclampsia and eclampsia has been impressive. Use of magnesium sulfate has gone from sporadic use by a handful of providers to use in more than 400 hospitals across the country in less than a decade. (According to the Federal Ministry of Health, in 2012 there were 1,042 secondary and tertiary health facilities in Nigeria.) This transition is particularly remarkable given the general challenges faced by the health infrastructure in Nigeria and the fact that magnesium sulfate involves a complicated clinical protocol.

The MacArthur Foundation shepherded this scale up of the use of magnesium sulfate by bringing together and supporting a complementary group of players to implement a multifaceted approach. The approach recognized that incorporating a new clinical practice into a healthcare system takes careful planning, policy support, resources, and time. Through sustained funding, and by paying attention to all the components necessary for the scale up of a new technology such as magnesium sulfate, the MacArthur Foundation and the Federal Ministry of Health of Nigeria, working in concert with professional societies and key research institutions, have demonstrated a successful path to saving women's lives that can be adapted and replicated in other countries. The story of how Nigeria successfully reduced eclampsia—one of its most prevalent causes of maternal mortality—is worth telling.

Appendix A: Nigeria Contacts List

Organization	Person Contacted	Position
CEDPA	Gabriel Yafeyi	Program Manager
Community Health Practitioners Registration Board	Shiono Bennibor	Registrar/CEO
Kano State MOH	Dr Abubakar Labaran Yusuf	Kano MoH Commissioner
	Dauda Sule Kanawa	Director Planning, Research & Statistics
	Hajiya Fatima Mailafiya	MCH Coordinator
Gwarzo General Hospital	Binta Halilu	Matron in charge of ANC
	Hadiza Labbo	Matron in charge of Labor Room
KNSG Hospital, Kano	Hajiya Hannatu Mohammed	Formerly with the State Ministry of Health, Kano
Aminu Kano Teaching Hospital	Dr Jamilu Tukur	Consultant
MacArthur Foundation	Dr. Kole Shettima	Director, Africa Office
	Erin Sines	Acting Director, Population and Reproductive Health
	Judith Helzner	Former Director, Population and Reproductive Health
Harvard School of Public Health	Dr. Ana Langer	Professor and Coordinator of Dean's Special Initiative in Women and Health and former CEO of EngenderHealth
Federal Ministry of Health	Dr. Kelechi Ohiri	Saving One Million Lives/FMOH
	Dr Moji Odeku	Former Deputy Director Reproductive Health, (now Project Director Nigerian Urban Reproductive Health Initiative)
Population Council	Dr. Salisu Ishaku	Sr. Program Manager, Nigeria
	Gloria Adeoye	Program Officer, Nigeria
	Ian Askew	Director of Reproductive Health Services and Research, Regional Office Kenya
	Charlotte Warren	Senior Associate, Maternal Newborn Health, USA
	Saumya Ramarao	Senior Associate, USA
Society of Gynecology and Obstetrics of Nigeria	Dr. Olusegun Adeoye	Program Manager
	Dr. Fred Achem	President
UNFPA Nigeria	Dr. Aliyu Yakubu	Program Specialist Reproductive Health

Appendix B: MacArthur Foundation Grants for Magnesium Sulfate in Nigeria

Name of Grantee/ Organization	Purpose	Duration of Grant	Size of Grant
Population Council/ Nigeria	Scaling up the use of magnesium sulfate for the treatment of eclampsia in northern Nigeria, including a focus on hospitals, on community level, and on the use of technology to improve maternal health outcomes. Renewal grant included support for policy advocacy for the use of magnesium sulfate for the management of eclampsia across all levels of the Nigerian healthcare delivery system; developing and testing a national curriculum for the pre-service training of nurses/midwives and community health extension workers on magnesium sulfate; and trainings to enable lower-cadre medical staff to identify and manage 'imminent' cases of eclampsia	46 months (2008; closed) 36 months (2011; closed) 36 months (2014; in force)	\$927,000 of \$2.4M; \$608,000 of \$2.2M \$650,000 of \$2.2M
Federal Ministry of Health	To pilot the administration of magnesium sulfate for the treatment of pre-eclampsia and eclampsia 10–12 states in Nigeria.	66 months (2008; in force)	\$500,000
EngenderHealth	To develop and test an e-learning module on the use of magnesium sulfate for the treatment of eclampsia, through partnership with <i>Oxford University's Maternal and Perinatal Health Institute</i> .	12 months (2008; closed)	\$310,000
Society of Gynecology and Obstetrics of Nigeria	Training of service providers on current evidence-based interventions for promoting safe motherhood, including magnesium sulfate for the prevention and treatment of eclampsia and misoprostol for the prevention of postpartum hemorrhage.	36 months (2007; closed)	A portion of \$250,000
Ipas	Build the knowledge and skills of medical interns at three teaching hospitals to provide reproductive and maternal healthcare, including use of magnesium sulfate to prevent eclampsia.	36 months (2012; in force)	\$500,000

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