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Reducing Disparities in Vaccination Rates Between Different Racial/Ethnic and Socioeconomic Groups

The Potential of Community-based Multilevel Interventions

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Abstract: There are well-documented disparities in vaccination rates between different socioeconomic and racial/ethnic groups in the United States. These disparities persist in spite of an overall increase in vaccination rates during the last decade and the implementation of several interventions that have aimed to increase vaccination rates in disadvantaged groups. Although many interventions are efficacious at improving vaccination rates under trial conditions, these interventions when extended to the general population frequently do not appreciably improve its health. Explanations for this limited intervention efficiency include poor adherence to protocols in real life versus idealized trial situations, changes in baseline so that the trial conditions are no longer replicable, and the contribution of other community-level factors that make it difficult to extend the trial methods to other communities. Multilevel community intervention trials recognize and address the multiple competing forces that shape the health of the population in cities and have the potential to increase vaccination rates among minorities and marginalized groups. **Key words:** *health disparities, interventions, multilevel, vaccination*

THERE are well-documented disparities in vaccination rates between different socioeconomic and racial/ethnic groups in the United States (Centers for Disease Control and Prevention [CDC], 1995, 2001). These disparities persist in spite of an overall increase in vaccination rates during the last decade and the implementation of several interventions that have aimed to increase vaccination rates in disadvantaged groups. For example, although a number of interventions have aimed to increase vaccination coverage among Blacks, national vaccination rates for influenza among Whites remain approximately one and a half times higher than they are among Blacks (CDC, 2001). This article discusses why interventions that are efficacious under trial conditions may fail to be effective at the population level, and how multilevel interventions may overcome some of these barriers and offer an innovative approach to reducing the disparities in vaccination rates in the United States.

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RACIAL/ETHNIC DISPARITIES IN VACCINATION COVERAGE IN THE UNITED STATES

For the last century, disparities in health outcomes have existed in the United States between racial/ethnic groups, between socioeconomic groups, and between groups at different levels of social advantage and

disadvantage (Adler & Ostrove, 1999; CDC, 2002; Gornick et al., 1996; Hargraves, 2001; Janes et al., 1999; Link & Phelan, 1996; Marmot, 1999; National Institutes of Health [NIH], 2002). Health disparities persist despite a national agenda directed toward minimizing health differences between groups, and, in the instance of many diseases, substantial effort aimed at improving the health of disadvantaged populations (CDC, 2002; NIH, 2002).

There are well-documented racial/ethnic disparities in vaccination rates in the United States. Focusing on vaccination rates for influenza as an example, in 1993, the Medicare-paid influenza vaccination rate among Whites was 37% compared to 17% among Blacks (CDC, 1995). Vaccination rates for influenza increased substantially throughout the United States in the 1990s, from 33% overall in 1989 to 66% in 1999 nationally among persons aged 65 or older (CDC, 1995, 2001). In 1999, influenza vaccination coverage was the highest it had ever been among Blacks, Hispanics, and Whites. Vaccination levels among Blacks and Hispanics, however, continued to be lower than among Whites (CDC, 2001). The influenza vaccination rate overall was 68% among Whites aged 65 or older, 55% among Hispanics, and 50% among Blacks. A study that used data from the 1996 Medical Expenditure Panel Survey compared influenza vaccination levels of different racial/ethnic groups among 2309 persons aged 65 or older (Marin et al., 2002). In this panel, 68.0% of Whites, 61.7% of Hispanics, and 47.3% of Blacks had current influenza vaccination. Adjustment for potential confounders, including health risk, age distribution, health status, family size, ambulatory care visits, and poverty level, failed to change this difference substantially. In fully adjusted multivariable logistic regression models, Blacks remained half as likely as Whites to have current influenza vaccination (Marin et al., 2002).

LOW VACCINATION RATES IN DISADVANTAGED GROUPS

Although most documented disparities in health in the United States pertain to differences across racial/ethnic groups, socioeconomic status and social disadvantage have also been shown to be associated with lower vaccination rates. For example, although all of the goals of the Childhood Vaccination Initiative (an intensive program to increase vaccination coverage among preschool-age children and eliminate vaccine-preventable diseases nationally) were met among Whites by 1996, 3 of the 5 coverage goals were not met for children living below the poverty level (CDC, 1997). From 1996 to 1999, the National Vaccination Survey (a phone survey of 28 US urban areas) found that vaccination coverage was consistently lower among children living below the poverty level (Klevens & Luman, 2001). Markers of socioeconomic status/social disadvantage that are associated with lower vaccination rates include not living in a self-owned residence, unemployment, having chronic illness, having less than a high school education, and immigration status (Mieczkowski & Wilson, 2002; Nichol et al., 1996; Petersen et al., 1999; Vryheid, 2001).

Marginalized groups have been shown to have particularly low vaccination rates. For example, hepatitis B vaccine had been available for a decade when a survey of nearly 3000 injection drug users in Baltimore showed that fewer than 10% of injection drug users had been vaccinated (Levine et al., 1995) despite substantial interest in health and vaccination in this population (Harrison et al., 1995; Vlahov et al., 1994). In one survey among immigrants and refugees, vaccination series completion rates ranged from 33% to 60% among children, substantially lower than completion rates among nonimmigrant children (Vryheid, 2001).

IMPROVING VACCINATION COVERAGE

Interventions

During the last decade, the overall increase in vaccination coverage nationwide has been attributed to several factors, including greater acceptance of preventive medical services by practitioners, new information regarding the effectiveness and safety of vacciness, initiation of Medicare reimbursement for a

number of vaccinations, and increased delivery and administration of vaccines by healthcare providers (Arden et al., 1986; Gross et al., 1994; Mullooly et al., 1994; Patriarca et al., 1985). At the national level, specific task forces, such as The National Task Force on Hepatitis B Vaccination, have focused on improving the availability and delivery of vaccines through established systems of service provision (Reilley, 2001).

At the local level, several innovative programs have shown successful increases in vaccination rates. In an assessment of different interventions aimed at increasing vaccination of children enrolled in the Special Supplemental Food Program for Women, Infants, and Children (WIC), children who were at sites where escort to a nearby pediatrics clinic was arranged were 5.5 times more likely to be immunized, and those who were at sites with voucher incentives were 2.9 times more likely to be immunized than were children at sites where passive referrals were provided (Birkhead et al., 1995). Voucher incentives in WIC participants have also been shown to increase childhood vaccination in inner-city populations (Hoekstra et al., 1998). A randomized controlled trial of an intervention that encouraged parents to vaccinate their children found that children in the intervention group had higher up-to-date vaccination (51% vs 39%) than did children in the control group (Kempe et al., 2001). In addition, media advertising has been shown to be an effective tool in increasing the acceptability of vaccination among minorities (Lashuay et al., 2000), among gay men (Friedman et al., 2000), and among children (Paunio et al., 1991). Vaccination rates have also been increased through mobilization of community-based organizations. For example, in response to a well-publicized low rate of measles-mumps-rubella vaccination in New York State, a program that mobilized community-based organizations to enroll children was able to show that after 9 months of operation, 73% of children were up-to-date for their vaccinations (Rosenberg et al., 1995).

Although these programs are all large-scale efforts, the success of relatively limited programs at increasing vaccination uptake also has been documented (Minkovitz et al., 2001). For example, there have been a series of randomized trials to test methods to enhance vaccination in hospital practice, including phone outreach, education added to visits, and hospital-based nurse outreach (eg, Dey et al., 2001). Although these results have shown only a moderate increase in vaccination, these results suggest that these methods should be tested among those not already receiving routine care. Recognizing that many disadvantaged populations do not have a usual source of care, the emergency department is frequently seen as a site for offering vaccination. In one study examining the feasibility of pneumococcal vaccination through an emergency department, of 1833 patient screening encounters, 1493 were identified as high risk and only 10% reported previous pneumococcal vaccination. One thousand one hundred seventy-three persons in this population were vaccinated, with the authors concluding that vaccination is both "necessary and feasible" given the context of patients "with little access to other vaccination services" (Slobodkin et al., 1999). A similar study found that only 3% of identified high-risk patients presenting to an inner-city hospital were vaccinated against *Pneumococus* and 18% had been vaccinated against influenza the previous year (Slobodkin et al., 1998). Sixty-one percent of high-risk patients with no contraindication to influenza vaccination were vaccinated (Slobodkin et al., 1998). A few studies have shown that special programs such as syringe exchange programs also can be used successfully to improve vaccination rates among marginalized, hard-to-reach populations (Des Jarlais et al., 2001; Stancliff et al., 2000).

Limitations

The success reported by individual programs aimed at improving vaccination coverage contrasts with the persistent disparities in vaccination coverage between different groups in the United States. For example, a recent cohort study of 13,674 Black and White Medicare beneficiaries with either managed care or fee-for-service insurance found an overall influenza coverage of 65.8%, and that Whites were substantially more likely to be

vaccinated than were Blacks (67.7% vs 46.1%) (Schneider et al., 2001). Although persons enrolled in managed care were more likely than those with fee-for-service insurance to receive influenza vaccination, vaccination prevalence among Whites was 18.6% higher than among Blacks in the managed care group (Schneider et al., 2001). There are several reasons why disparities in vaccination coverage persist despite intense efforts on the part of public health practitioners and governmental institutions. Three possible explanations include the difficulty in expanding programs from a limited trial to a wide-scale intervention, changes in baseline so that the trial conditions are no longer replicable, and the contribution of other community-level factors that make it difficult to extend the trial methods to other communities. We discuss each of these in turn.

Public health interventions, particularly interventions that are rigorously evaluated and eventually published in the peer-reviewed literature, rest on the implementation of protocols to achieve the desired outcome. Therefore, programs are carefully planned and resources are appropriately diverted to ensure that the intervention is implemented as planned. As discussed above, in one program aimed at improving vaccination coverage among children enrolled in WIC, New York State public health authorities designed an intervention whereby an escort was provided to take the child from the WIC site to a nearby pediatric clinic for vaccination (Birkhead et al., 1995). This intervention trial arm was then compared to a control group whose participants were passively referred to the clinic for vaccination. The intervention group was found to be more than 5 times more likely to be immunized in this trial than was the control group (Birkhead et al., 1995). In another intervention discussed previously, provision of pneumococcal vaccination to high-risk disadvantaged populations through an emergency department was found to be feasible, and the trial immunized more than a 1000 persons in a 2-month period (Slobodkin et al., 1999). The success of both these efforts, as does the success of all other comparable interventions, rests on the infrastructure developed to successfully implement the intervention (eg, investigators, program managers, nurses), on the cooperation of other healthcare providers (WIC clinic employees or emergency department practitioners in these 2 examples), and on the availability of resources to implement the programs (eg, human resources to escort children to vaccination clinics, financial resources to pay extra staff).

Although efforts such as these are feasible in the short term, when their success depends on dedicated investigators and public health practitioners, they often fall short in effectively improving vaccination rates in the long term. Beyond the confines of the trial, these interventions must be implemented system wide to achieve sustainable population-level change and the factors that have been shown to be efficacious in the context of a limited trial must be replicated on a much larger scale. Such an expansion of successful interventions, however, is often beyond the scope of the public health practitioners who carried out the initial intervention. Rather, such expansions of programs enter the realm of policy, at the local, state, or federal level. Therefore, continuation of a successful program to offer vaccination to disadvantaged populations through the emergency department would require adaptation of multiple systems to the program, including hospital commitment to the program in the long term, sustainable availability of vaccination resources, and the cooperation of a number of institutions governing the allocation of human resources (eg, program management and administration). Ultimately, competing interests frequently result in a failure of expansion of successful interventions to levels that could achieve meaningful population-level change. When programs are implemented on a broad scale, their implementation is often compromised, with specific elements of the successfully implemented intervention altered to make the program feasible in the long term. Such compromises may have an unpredictable effect on trials that had been efficacious under controlled conditions, but whose effectiveness is untested on a larger scale.

A second barrier frequently encountered in the translation from controlled intervention to wide-scale program implementation is the fact that the conditions for which the intervention was initially carefully designed are no longer applicable in the larger population. Interventions are designed to account for conditions prevailing at the time of program inception. For example, an intervention aimed at increasing vaccination awareness through the mass media will be rooted in attitudes prevailing toward vaccination at the time of program design. It takes several years, however, to go from program design to implementation, to evaluation, and then to presentation of the findings to a wider audience. It is frequently the case that the conditions for which the intervention was designed are no longer applicable. In the context of an intervention that makes use of the mass media, the proven efficacy of a specific set of media images cannot then be generalized to have widespread effectiveness if the initial context for which the media images were created has now changed.

The observation that baseline conditions for which interventions are developed may change before there is an opportunity to extend the intervention to a larger scale is part of a broader limitation of focused interventions. Specifically, interventions are primarily designed to focus on one aspect that is considered problematic. In the context of vaccination rates, interventions are designed to overcome a factor that is considered to be a barrier to successful vaccination. Factors that influence access to care in general include having a regular source of care, socioeconomic status, and insurance status (Janes et al., 1999; Lambrew et al., 1996). Specific studies have shown that factors that affect vaccination rates include attitudes and beliefs about vaccination (Harrington et al., 1999; Lewis-Parmar & McCann, 2002; Nichol et al., 1992, 1996; Pearson & Thompson, 1994), attitudes about healthcare (Fowles & Beebe, 1998), past use of healthcare (Fiebach & Viscoli, 1991; Pearson & Thompson, 1994), knowledge of burden of the disease (Santibanez et al., 2002), cost as a primary barrier to healthcare (Merkel & Caputo, 1994; Richardson & Michocki, 1994), lack of transportation (Ganguly et al., 1987), and vaccination delivery methods (Gyorkos et al., 1994). As such, many interventions are designed to target these factors. For example, some of the interventions discussed above target access to vaccination (eg, Birkhead et al., 1995), attitudes about vaccination (e.g., Paunio et al., 1991), and vaccination delivery (eg, Slobodkin et al., 1998; Stancliff et al., 2000). This focus on one (or at best a few) manipulable barrier to vaccination often fails to recognize the contribution of other factors, at the individual or community level, that may interact with the factor of interest and that may also shape vaccination rates. Although an intervention that focuses on improving vaccination opportunities for disadvantaged populations (through an emergency department program or through a syringe exchange program) may well successfully immunize such populations, that intervention is grounded in the circumstances of the time and place when it was designed and implemented. As a result, extension of the intervention methods to the broader population or to a different population at a different time may well not prove effective.

The difficulties inherent in extending demonstrably effective intervention trials to the general population, although not necessarily unique to vaccination interventions, contribute to the ongoing disparities in vaccination rates between different groups. These difficulties, however, also suggest possible solutions that may be incorporated into an alternative method of designing interventions that may address some of these problems. In the next section, we discuss how multilevel interventions can be designed to meet some of these challenges, and as such have the potential to improve disparities in vaccination rates in the United States.

MULTILEVEL APPROACHES TO IMPROVING VACCINATION COVERAGE

Theoretic framework

Multilevel approaches to interventions are grounded in the social ecological theory.

Briefly stated, the social ecological theory holds that individual characteristics (eg, precautionary behaviors like vaccination) that have consequences such as disease or health are shaped by the social environment (Kaplan, 1999; Krieger, 1991; Susser & Susser, 1996). The social environment involves structural factors (eg, civic community, government), social characteristics (eg, social norms), and processes (eg, diffusion of innovation) that combine to shape individual characteristics. Vaccination is only one example of a public health goal that could benefit from multilevel consideration. Figure 1 presents an example of how a multilevel approach to vaccination intervention would consider the different levels of influence that determine vaccination rates in specific groups. First, at the state level, regulation shapes the scope of services covered by public health insurance (eg, Medicaid) and barriers to access of these services. Therefore, state-level factors are relevant to the circumstance on which the public health professional may wish to intervene. Second, at the municipal level, distribution of resources (eg, health clinics, health professionals), community attitudes toward vaccination, and collective efficacy, that is, the community's ability to mobilize to obtain vaccination, may all affect the success of the vaccination program. Third, at the individual level, individual education and social circumstances (eg, income, having children, social supports) may influence whether an individual will be vaccinated.

Importantly, vaccination efforts that avoid the complexity of barriers to vaccination and of changing individual behavior are likely insufficient for sustainable, long-term improvement in vaccination rates and for minimizing disparities in vaccination between different racial/ethnic and socioeconomic groups. These ongoing disparities, coupled with the efforts that have been expended to improve vaccination rates, suggest that moving from an efficacious intervention to effective population-level interventions requires a recognition that interventions need to proceed simultaneously in multiple dimensions at different levels. The traditional approach to intervention research is to isolate and test components (eg, media messages, insurance financing strategies), ideally in randomized controlled trials. The substantial barriers that these interventions then face, however, in being generalized to the broader population suggest that early consideration of other factors that are important for translating the vaccination trial to a broader scale will likely be more effective in the long term. Concurrent with this view, recent reviews of intervention studies have overwhelmingly concluded that population-level intervention research should include an expanded appreciation of

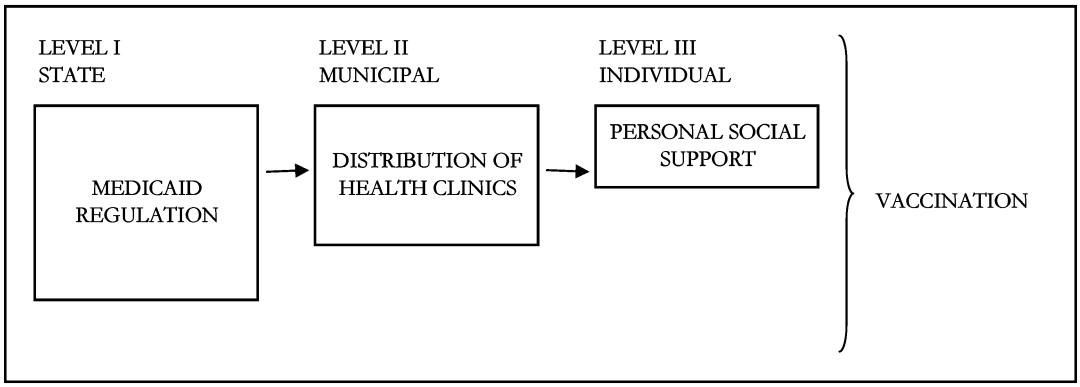

Figure 1. Multilevel interventions to improve vaccination rates, an example. The examples provided at each of the levels are for illustration purposes. There are several more variables that can be considered at each level. Similarly, there are many other levels that can be important determinants of vaccination rates.

the multiple levels of influence on health behavior (Fortmann et al., 1995; Sorensen et al., 1998).

Potential advantages

Multilevel approaches to vaccination efforts have the potential to be an invaluable addition to the intervention armamentarium and to help address some of the limitations faced in generalizing intervention trials. In the context of vaccination, multilevel interventions must recognize that barriers to vaccination are neither independent of one another nor from the community context within which the barriers are observed. For example, we can consider the challenge of increasing vaccination rates and decreasing disparities in vaccination rates in a particular metropolitan area. Vaccination rates (overall and within specific groups) are likely a product of several factors as shown in Figure 1. As discussed throughout this article, typical vaccination interventions have traditionally targeted one facet that determines the likelihood of vaccination. For example, an intervention may work to increase access to vaccination services (eg, reducing barriers to eligibility at health clinics) or to improve attitudes toward vaccination (eg, through media campaigns or working with key community leaders). These interventions may well prove successful and increase vaccination rates in the community of interest. Barriers to expanding this intervention, however, may include difficulties in sustaining the intervention after the intervention trial has been completed, changes in the baseline factors at other levels that make the intervention trial itself obsolete, and challenges translating the intervention to diverse communities where factors at the other levels differ.

Multilevel interventions aim to address the multiple determinants that can potentially influence effective vaccination programs to overcome some of these challenges. A multilevel intervention may include elements of working with the state legislature to increase the scope of services covered by public insurance, a media campaign to increase awareness of the availability of these services and to influence social norms about vaccination, and a program that offers escorts to vaccination clinics to persons with limited social supports. In so doing, the multilevel intervention addresses barriers to vaccination at multiple levels. Since they are implemented as a comprehensive intervention strategy, multilevel interventions have the potential to move beyond the experimental trial phase and to be relatively easily generalized to the population after the formal trial phase is completed. If implemented in an experimental fashion (eg, through randomizing city or neighborhood units in a trial), the multilevel intervention trial can also provide empiric information about the relative impact of each of these levels that ultimately can guide future interventions in different contexts. In addition, the multilevel intervention, sensitive to community conditions and how they may be changing, can also avoid the potential for changing baseline conditions for which the intervention was designed, making the intervention obsolete by the time it is completed. Community-based participatory methods have emerged as among the more effective methods through which multilevel interventions can become aware of community conditions (see Israel et al., 1998, for a comprehensive review of community-based methods). Community-based methods incorporate community members as an integral part of the research and intervention team behind multilevel trials, making the intervention responsive to community needs and to barriers that may be faced in improving vaccination rates. Community participation in the implementation of multilevel trials can bring light into factors that may otherwise not be apparent to the public health practitioner. For example, attitudes toward vaccination are often instrumental in shaping vaccination rates (Nichol et al., 1996), and can be difficult to fully appreciate for persons who are not community members.

Limitations of multilevel interventions

Multilevel interventions face limitations, some of which they share with all other forms of vaccination interventions and some

of which are particular to multilevel interventions. First, multilevel interventions are limited, as are all other interventions, by the scope of the intervention itself and by the limited resources that may be available in the posttrial period to generalize the implementation to a larger population. The scope of the multilevel intervention (including both the size of the population that is included in the intervention and the number of levels of influences that are intervened upon) is ultimately limited by the availability of financial and human resources. Implementation of multilevel trials requires careful supervision of standardized interventions at multiple levels, effectively multiplying the amount of work inherent in standard interventions that target single levels of interest. Second, as apparent in this discussion, multilevel interventions are uniquely resource-intensive during their implementation. Although we are not aware of any formal cost-benefit analysis of multilevel interventions versus standard interventions that have been published in the peer-reviewed literature, it is plausible that the benefits of multilevel interventions in the short term, that is, greater population efficiency that can be translated easily to other communities and obviating the need for many other ineffective standard interventions, and in the long term, that is, through improving health among populations that have historically borne a substantial burden of disease, outweigh the upfront costs inherent in multilevel interventions. Rigorous cost-benefit evaluation of multilevel trials is needed to shed light on this point. Third, multilevel intervention trials are complicated by methodologic considerations that are unique to intervention and analysis across levels. The design of intervention trials at multiple levels requires the enrollment of sufficient trial participants, both at the individual level and at the group level. As such, for the effects of multiple levels to be detected, sufficient groups (eg, communities, cities) must be included in the trial to provide sufficient statistical power for the detection of meaningful effect sizes. Although some authors have now begun to provide calculations that can guide these sample size estimates (cf. Hoover, 2002), the science of multilevel interventions remains in its infancy. Importantly, the fact that such trials require the inclusion of multiple groups of interest means that a larger sample size than that which would be required for standard interventions is necessary for multilevel interventions, with important resource implications as previously discussed.

Thus far, there have been very few multilevel interventions implemented, evaluated, and described in the peer-reviewed literature (see, eg, Komro et al. 2001; MacLean et al., 2003) and none that we are aware of that pertain specifically to vaccination. As such, ideas about the implementation of multilevel interventions, their practical limitations, and their potential remain untested. It is worth noting that some of the more successful vaccination programs in history can be construed as multilevel programs, even if they were not explicitly formulated as such. For example, the successful global smallpox eradication campaign engaged multiple federal systems, health systems, local attitudes, and individual barriers to access to vaccination to deliver vaccines to those at risk of smallpox exposure worldwide (Henderson, 1987). Over the last decade, there has been a tremendous increase in multilevel analysis (Diez-Roux, 2002; O'Campo, 2003), primarily using extant data, which has demonstrated the importance of factors at multiple levels in shaping health behavior and individual disease. Both formal multilevel interventions currently underway in many centers throughout the United States and future publications have the potential to advance our understanding of multilevel interventions and the roles they can play in improving health outcomes in different groups.

CONCLUSIONS

Persistent disparities in vaccination rates between racial/ethnic and socioeconomic groups, despite substantial federal and local efforts at minimizing disparities, suggest that the traditional approaches to improving vaccination coverage may be insufficient. There

are several reasons why interventions that are efficacious in the context of a trial may be difficult to translate effectively to the general population. Multilevel interventions offer one way of overcoming some of these challenges. By recognizing that factors at multiple levels may influence the barriers to vaccination faced by specific populations, multilevel interventions may improve vaccination rates in the general population in the long term, and, consequently, contribute to minimizing disparities in health.

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