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Perspective

Leading scientists' contributions to organized research: Gu Fangzhou and the development of China's attenuated live poliovirus vaccine ☆

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ABSTRACT

This article examines Gu Fangzhou's leadership in the development of China's live poliovirus vaccine from the perspective of organized research. In response to the poliomyelitis (polio) epidemic of the 1950s, the Chinese government mobilized research institutions, production facilities, and administrative resources to establish a nationwide collaborative system for vaccine development. Within this framework, Gu played a pivotal role in aligning scientific research with national public health needs. His work demonstrates that the effectiveness of organized research depends not only on institutional coordination and concentrated resource allocation, but also on scientists' strategic judgment, leadership, innovation, and sense of responsibility. The development and widespread application of China's polio vaccine not only succeeded in controlling the epidemic, but also established a comprehensive technological platform for the research, development, and production of polio vaccines. This provided decisive support for China's eventual achievement of polio free and contributed a Chinese approach to global public health.

1. Introduction

Unlike research driven primarily by scientists' individual interests and free exploration, organized research is oriented toward national strategic needs and aims to accomplish major national scientific and technological tasks efficiently. Under this model, the state or national-level research institutions define research objectives around strategic issues, concentrate resources, and coordinate research capacity across organizations and disciplines. This mode of organized research is characterized by organization, institutionalization, systematization, and collaboration. Specifically, organization refers to a scientific research community with an independent organizational form, unified objectives, and stable continuity. Institutionalization denotes a comprehensive institutional framework encompassing rules for internal management, operational support mechanisms, and relatively unified ideas, values, and guiding principles recognized both within and outside the organization. Systematization is reflected in a rigorous internal hierarchy, clearly defined departments and classifications, stable channels of communication, unified management and coordination, and the concentrated allocation of personnel, funding, research facilities, and equipment. Finally, collaboration refers to coordinated problem-solving across fields, teams, disciplines, and research directions under unified planning and toward common objectives, supported by shared collaborative values and corresponding organizational structures.[1]

In the 1950s, poliomyelitis (polio) emerged as a major infectious disease threatening the health of children in China. Driven by the country's urgent public health needs, China rapidly mobilized expertise and resources across virology, biological products, vaccine production, and quality control to undertake a coordinated research effort. Gu Fangzhou was not only a key scientist in this endeavor but also an important node linking scientific judgment, administrative decision-making, and organizational implementation. As the leader of the collaborative group, he contributed to the development of production processes, quality standards, vaccine formulation, and the training of scientific and technical personnel, ultimately helping China establish a relatively comprehensive system for the research, production, and quality control of poliovirus vaccines. The development of the polio vaccine in China represents a particularly illustrative case of organized research. From the perspective of state-organized research, this article examines Gu Fangzhou's contributions as a scientific leader and seeks to illuminate the indispensable interaction between institutional coordination and individual scientific agency.

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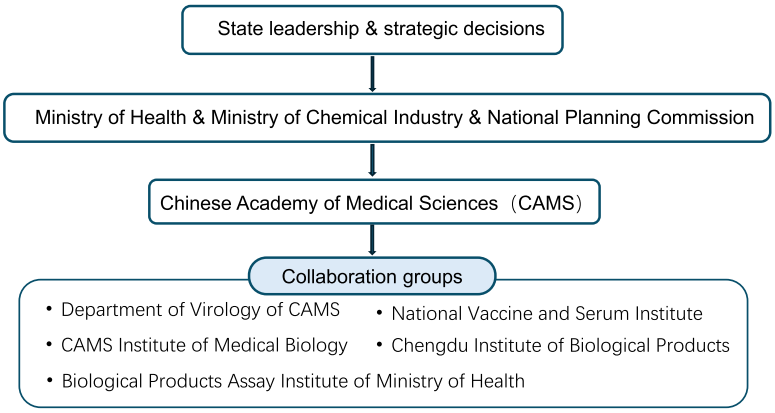


Fig. 1. The multilevel management structure of organized research in the development of China's attenuated live poliovirus vaccine.

2. The polio epidemic and state-organized research

In 1955, an outbreak of polio occurred in Nantong, Jiangsu Province, with a total of 1,680 reported cases of paralysis and an incidence rate of 32.1 cases per 100,000 population.[2] Polio subsequently spread in multiple parts of China, attracting considerable attention from both the government and the medical community and becoming a major public health challenge.

The Chinese government attached great importance to polio prevention and control. In 1958, the Ministry of Health of China designated the research and production of an inactivated poliovirus vaccine as an emergency project and called for strengthened infrastructure development and production preparations. The Chinese Academy of Medical Sciences (CAMS) assumed major organizational responsibilities, with its president, Shen Qizhen, involved in key aspects including site selection, infrastructure construction, and personnel allocation. The local government of Yunnan province also provided corresponding support. As a result, a multilevel organizational structure was established, consisting of a central decision-making mechanism, which was coordinated by the Ministry of Health and implemented by CAMS and the collaboration group (Fig. 1).[3] Within this structure, the Ministry of Health was primarily responsible for task deployment, interdepartmental coordination, and overall resource allocation. CAMS translated the national mission into specific research and construction tasks. The collaboration group composed of multiple institutions—including the Department of Virology of CAMS, CAMS Institute of Medical Biology, National Vaccine and Serum Institute, Biological Products Assay Institute of Ministry of Health, Chengdu Institute of Biological Products—was responsible for integrating scientific and technical resources and conducting coordinated research.[4] The members of the collaboration group were assigned specialized responsibilities according to their specific areas of expertise, covering a wide range of activities including the breeding and management of experimental monkeys, preparation of solutions and culture media, tissue culture, virus cultivation, animal experiments, quality control and testing, equipment supply, and production management.[5] After years of exploration, the collaboration group successfully digested and absorbed the technology for manufacturing liquid live polio vaccine and established production guidelines, verification standards, and management rules of its own. The development of live polio vaccine in China thus progressed from technology introduction and digestion to independent production.

This multilevel collaborative system demonstrates four characteristic features of organized research. First, the collaboration group, composed of multiple institutions, developed into a stable and enduring scientific research community, reflecting the organizational dimension of organized research. Second, the establishment of China's own standards and procedures for the production and quality control of polio vaccines ensured the stable advancement of vaccine research and production, demonstrating its institutionalized character. Third, the hierarchical structure of central authorities, ministries, research academies and institutes, and the collaboration group, together with the corresponding allocation of resources, reflected a systemic character. Finally, the joint efforts of different institutions across organizational and disciplinary boundaries demonstrated the collaborative character of organized research. Overall, the organized research model effectively leveraged institutional strengths to concentrate resources on major national tasks. A clear division of responsibilities ensured well-defined research objectives, improved the efficiency of the endeavor, and laid the foundation for the rapid production of the vaccines.

3. Gu fangzhou's contributions to organized research

As the leader of China's polio vaccine program, Gu Fangzhou consistently aligned his research with national needs. A trained virologist initially researching encephalitis, he resolutely accepted the state's call to develop a polio vaccine, leaving his familiar field to tackle new risks and challenges.[6] By prioritizing the country's disease control efforts over his personal academic path, Gu embodied the devotion and responsibility of a scientist dedicated to public health.

Amid international debate over vaccine types (inactivated and live attenuated vaccines) and China's unresolved path, Gu stepped forward with a strategic recommendation. After weighing international evidence against China's national conditions, he advised the Ministry of Health to adopt the live attenuated vaccine. The choice between inactivated vaccine and live attenuated vaccine went beyond academic debate; rather, it was a complex decision involving safety, production scale, costs, resources, and logistics. Inactivated vaccines had favourable safety profiles but were expensive, required multiple injections, and depended heavily on large numbers of medical personnel and substantial healthcare resources, making rapid coverage across China's vast rural areas difficult. By contrast, oral polio vaccine (OPV) could induce intestinal immunity, interrupt viral transmission effectively, and was better suited to large-scale production and distribution. However, their potential risks had long been a concern.[7] This decision not only set a sound technological direction for polio prevention and control in China but also enabled the country to build a nationwide immune barrier faster and at lower cost. Grounded in scientific rigor and a strong sense of responsibility, Gu laid a solid scientific foundation for the eventual polio-free in China.

After the successful development of the liquid oral vaccine, Gu quickly recognized that success in the laboratory did not automatically translate into success in public health practice. The liquid vaccine required cold-chain transportation and dilution before administration, creating serious obstacles to its use in rural and remote areas. Having learned of research on candy-form vaccines during a study visit to the Soviet Union, Gu proposed developing a solid sugar-pellet formulation. The Institute of Medical Biology collaborated with Shanghai Sine Pharmaceutical Factory, using existing experience of pill-rolling method, which had gradually undergone a transformation towards mechaniza-

tion and modernization due to interaction between Chinese and Western medicine in modern times. Through repeated experimentation, researchers optimized the sugar-pellet formula, low-temperature manufacturing process, uniformity of viral content, and vaccine stability, ultimately producing the sugar-pellet vaccine successfully.[8] The OPV in dragee candy was not merely a change in dosage form; it was a systemic innovation tailored to China's disease-control system.

Gu devoted his life to China's polio elimination effort, safeguarding children's health and advancing human welfare. In 2000, when China was certified polio-free, Gu, as a member of the National Certification Committee for Polio Eradication, solemnly signed the certification report. In 2001, the Ministry of Health named him an Advanced Individual in the National Polio Elimination Program, and he received the Ho Leung Ho Lee Foundation Prize for Scientific and Technological Progress. In 2012, the Chinese Society for Immunology presented him with a Lifetime Achievement Award; in December of the same year, CAMS and Peking Union Medical College (PUMC) also conferred on him a Lifetime Achievement Award. In 2016, the project "Development of a Series of Polio Vaccines and Their Application in China's Childhood Immunization Program," led principally by Gu, was selected as one of the ten major scientific and technological achievements commemorating the 60th anniversary of the CAMS. In 2017, the bivalent live attenuated polio vaccine produced in China received WHO prequalification. Chinese polio vaccines met international standards and entered the global market, supporting the global polio eradication initiative. In 2019, Gu was awarded the national honorary title of "People's Scientist." In 2025, the 43rd session of the United Nations Educational, Scientific and Cultural Organization (UNESCO) General Conference approved the inclusion of activities marking the centenary of Gu's birth in UNESCO's program of anniversaries, reflecting international recognition of his scientific achievements and China's efforts to eliminate polio.

Gu's historical significance lies not only in his role in introducing, assimilating, adapting, and further innovating polio vaccine technology, thereby localizing vaccine research and production in China,[9] but also in his ability to integrate scientific judgment, technological choice, and organizational coordination under multiple constraints including urgent national need, an unsettled technological route, weak production conditions, and difficulties in mass vaccination. Gu acted as a collaborative leader and successfully advanced research findings into large-scale production and public health practice. Gu's work demonstrates that organized research does not mean replacing scientific creativity with administrative structures; rather, it involves the interaction between institutional resources and scientific agency, embedding individual expertise, strategic judgment, and leadership capabilities into national scientific and technological missions.

4. Conclusion

The history of China's polio vaccine development demonstrates that state-organized scientific research neither replaces scientific inquiry with administrative management nor stifles individual scientific creativity through collective organization. Its effective operation relies on the organic integration of a clear national mission with mechanisms that are organized, institutionalized, systematic, and collaborative. In the state-led, organized research effort to develop the polio vaccine, Gu fully exemplified the responsibility and commitment required of a scientific leader: proactively adjusting research directions to align with national needs; making strategic judgments based on evidence and national realities amidst international competition over technical approaches; leading and coordinating multi-institutional collaboration and key technical breakthroughs; and establishing institutionalized standards for vaccine production and quality control.

Entering the 21st century, global public health continues to face challenges such as emerging infectious diseases, imbalances in vaccine supply, and the need for rapid responses to sudden outbreaks. Gu's legacy suggests that building organized research systems to address major public health issues requires maintaining a positive interplay between institutional strength and scientific agency, thereby empowering scientists to participate in major national scientific and technological missions.

Authors' contributions

Wu M: Conceptualization, Methodology, Investigation, Writing – original draft, Supervision, Funding acquisition; Yan YC: Investigation, Writing – original draft; Chen C: Writing – review & editing. All authors reviewed and approved the final version of the manuscript.

Declaration of generative AI and AI assisted technologies use

During the preparation of this work, the authors used large language models to assist with language editing, translation, and figure formatting. After using this tool/service, the authors closely reviewed and edited the content as needed and take full responsibility for the final content of the publication.

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Conflict of interest disclosure

The authors declare no potential conflict of interest.

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