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Research Article

Physician–Pharmacist Collaboration in Optimizing Medication Management for Chronic Diseases in Primary Health Care

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Abstract:

Physician-pharmacist collaboration in primary health care represents a transformative and evidence-based model for addressing the pervasive challenge of suboptimal medication management in chronic diseases. By integrating the clinical diagnostic skills of physicians with the pharmacotherapeutic expertise and accessibility of pharmacists, this synergistic partnership moves beyond traditional siloed care to create a cohesive, patient-centered approach. Structured collaboration, often facilitated through co-location, shared health records, and formal practice agreements, systematically improves clinical outcomes such as blood pressure and glycemic control, enhances medication safety and adherence, and increases patient satisfaction. Furthermore, it proves to be economically rational by reducing costly complications and hospitalizations. Despite facing barriers related to financing, regulation, and workflow integration, the model's demonstrated success across the triple aim of better health, better care, and lower cost positions it as an essential component of a sustainable and effective primary care system for the growing global burden of non-communicable diseases.

1. Introduction

The global burden of chronic non-communicable diseases (NCDs) represents one of the most significant public health challenges of the 21st century. Conditions such as hypertension, diabetes mellitus, dyslipidemia, heart failure, and chronic obstructive pulmonary disease (COPD) are leading causes of mortality, morbidity, and disability worldwide. Their management is a long-term, often lifelong, endeavor that places immense strain on healthcare systems, economies, and the quality of life of patients and their families [1]. Primary health care (PHC) stands as the first and most continuous point of contact for individuals with these chronic conditions, tasked with the crucial roles of prevention, diagnosis, treatment, and long-term follow-up. However, traditional models of care in PHC, often characterized by physician-centric, episodic, and disease-focused approaches, have proven insufficient in addressing the complex, multifaceted needs of chronic disease management [2].

A cornerstone of effective chronic disease control is optimal medication management, which encompasses far more than the simple act of prescribing. It involves appropriate initial drug selection, careful titration to achieve therapeutic goals, ongoing monitoring for efficacy and safety, management of complex polypharmacy, ensuring adherence, and providing comprehensive patient education. Suboptimal medication management is a pervasive issue, manifesting as poor disease control, increased adverse drug events (ADEs), hospitalizations due to preventable causes, and unnecessary healthcare expenditures [3]. The reasons for this are multifactorial: overwhelming physician workloads, limited consultation times, the increasing complexity of pharmacotherapy, and fragmented communication within the healthcare team all contribute to the gap between evidence-based guidelines and real-world patient outcomes [4].

In this landscape of complexity and system strain, the paradigm of interprofessional collaboration emerges not as a mere enhancement but as a fundamental necessity. The World Health Organization (WHO) has repeatedly emphasized the critical role of collaborative practice in strengthening health systems and improving health outcomes, particularly for chronic conditions [5]. Among the most synergistic and well-studied collaborative relationships in PHC is that between physicians and pharmacists. This partnership leverages the distinct yet complementary expertise of each profession to create a cohesive, patient-centered medication management system. Physicians bring their diagnostic acumen, understanding of disease pathophysiology, and comprehensive view of the patient's health status. Pharmacists contribute their specialized, in-depth knowledge of pharmacotherapy, pharmacokinetics, pharmacodynamics, medication safety, and their unique accessibility to patients [6].

The integration of clinical pharmacists into the PHC team represents a transformative shift from a role historically focused on medication dispensing to one actively engaged in direct patient care and shared decision-making. This collaborative model moves beyond simple consultation to structured, team-based care where responsibilities are shared according to professional scope and patient need. The potential benefits are substantial: improved clinical outcomes through better achievement of treatment targets, enhanced patient safety through rigorous medication review and reconciliation, increased patient empowerment through tailored education, and improved cost-effectiveness of care by optimizing resource use and preventing costly complications [7, 8].

2. The Evolution and Conceptual Frameworks of Physician-Pharmacist Collaboration

The collaboration between physicians and pharmacists is not a novel concept, but its nature and scope have evolved dramatically. Historically, the relationship was often hierarchical and indirect, with the pharmacist's role confined to the dispensary, acting upon the physician's orders with minimal clinical interaction. The late 20th and early 21st centuries, however, witnessed a paradigm shift driven by the increasing complexity of drug therapy, the patient safety movement, and a growing recognition of medication-related morbidity. This evolution was underpinned by the formal recognition of pharmaceutical care as a philosophy of practice, defined as the responsible provision of drug therapy for the purpose of achieving definite outcomes that improve a patient's quality of life [9]. This concept laid the groundwork for pharmacists to assume direct responsibility for patient outcomes related to medication.

Concurrently, several conceptual frameworks have been developed to define and guide collaborative practice. One foundational model is the Collaborative Care Model, which emphasizes shared responsibility, interdependence, and mutual trust in planning and delivering patient care. In this model, roles are defined not by tradition but by patient needs and the specific expertise of each professional [10]. Another key framework is the Chronic Care Model (CCM), which identifies productive interactions between a prepared, proactive practice team and an informed, activated patient as the engine of high-quality chronic illness care. The integration of a clinical pharmacist is a powerful operationalization of the "prepared, proactive practice team" element of the CCM, providing the necessary support for system redesign, decision support, and self-management coaching [11].

Furthermore, the concept of "collaborative drug therapy management" (CDTM) has emerged as a legal and practical mechanism for formalizing this partnership. CDTM involves agreements, often protocol-driven, that authorize pharmacists to perform specific patient care functions, such as initiating, modifying, or monitoring drug therapy, under defined conditions and in collaboration with a physician or a healthcare organization. These agreements provide a structured framework that clarifies responsibilities, enhances communication, and ensures accountability, thereby facilitating a higher level of integrated practice [12]. The evolution from siloed roles to integrated, team-based care, guided by these frameworks, is essential for addressing the multifaceted medication-related needs of patients with chronic diseases.

3. Impact on Clinical, Humanistic, and Economic Outcomes

A robust and growing body of evidence from numerous randomized controlled trials, systematic reviews, and meta-analyses substantiates the positive impact of physician-pharmacist collaboration in primary care across a triple aim of outcomes: clinical, humanistic, and economic.

In terms of **clinical outcomes**, collaborative models have consistently demonstrated superior performance in achieving and maintaining disease control targets. For hypertension, studies show that pharmacist interventions, including protocol-driven management and titrations in collaboration with physicians, lead to significantly greater reductions in systolic and diastolic blood pressure compared to usual care [13]. In diabetes management, pharmacist involvement is associated with significantly greater reductions in HbA1c, improved attainment of lipid and blood pressure goals, and more effective medication intensification when needed [14]. Similarly, for conditions like heart failure, COPD, and anticoagulation management, collaborative care improves guideline-concordant therapy, reduces treatment errors, and enhances monitoring, leading to fewer disease exacerbations and complications [15].

Humanistic outcomes, which encompass the patient's experience, knowledge, and behavior, are equally important. Medication adherence, a critical determinant of therapeutic success, is markedly improved through pharmacist-led interventions such as simplified regimens, tailored education, blister packing, and regular follow-up. Patients report higher levels of satisfaction with care when they receive attention from a pharmacist who can spend time addressing their medication concerns in detail [16]. Furthermore, collaborative care enhances patient activation and self-management skills. Pharmacists are uniquely positioned to provide education on disease states, medication purpose, side effect management, and lifestyle modifications, empowering patients to take a more active role in their own health [17].

The **economic argument** for collaboration is compelling. While integrating a pharmacist into the PHC team represents an initial investment, the overall economic impact is highly favorable. Studies consistently demonstrate that these models are cost-effective or cost-saving. The savings are generated through multiple pathways: the prevention of costly ADEs and drug-related problems, the reduction in hospital admissions and

emergency department visits (particularly for ambulatory care-sensitive conditions), the decreased need for physician visits for routine medication management, and the optimization of medication regimens which can reduce wasteful polypharmacy and promote the use of cost-effective therapeutics [18]. This creates a powerful value proposition for healthcare payers and systems seeking to improve outcomes while managing finite resources.

4. Key Components and Models of Successful Integration in Primary Care

Successful integration of pharmacists into PHC teams is not a monolithic process but requires careful consideration of several core components and can be implemented through various practice models tailored to local contexts and resources.

A foundational component is **physical co-location**. Having the pharmacist embedded within the primary care clinic, rather than in a remote or community pharmacy, is critical for fostering informal communication, facilitating warm handoffs, enabling immediate consultation on complex cases, and building trust and camaraderie within the team. Co-location transforms the pharmacist from an external consultant to a core team member [19]. Closely linked is the need for **shared health information technology (IT)**. Access to a common electronic health record (EHR) is indispensable. It allows the pharmacist to review the full patient record (history, diagnoses, labs, physician notes), document their own clinical assessments and interventions directly in the patient's chart, and communicate efficiently with physicians through in-system messaging. EHR integration also facilitates population health management, allowing pharmacists to identify and reach out to patients who are not meeting therapeutic goals [20].

Defining clear **roles, responsibilities, and scope of practice** through formal agreements is essential to avoid role ambiguity and conflict. Collaborative practice agreements (CPAs) or CDTM protocols should specify the conditions the pharmacist can manage, the medications they can initiate or adjust, the required monitoring parameters, and the process for physician referral or escalation. This clarity empowers the pharmacist to work at the top of their license and provides a legal and professional safety framework [21]. Finally, the success hinges on **effective interprofessional communication**. Regular, structured interactions, such as joint patient case reviews, team huddles, and shared clinic schedules, must complement the ad-hoc communication enabled by co-location. Mutual respect, trust, and a shared commitment to patient-centered goals are the cultural bedrock upon which these communication channels are built [22].

Several operational models exist. The **comprehensive medication management (CMM)** model is a highly structured, patient-centric approach where the pharmacist conducts thorough, scheduled appointments to perform medication therapy reviews, identify and resolve drug therapy problems, develop a personalized care plan, and provide longitudinal follow-up. This is often supported by billing for cognitive services [23]. The **colorectal, embedded clinic pharmacist** model involves the pharmacist managing specific chronic disease panels (e.g., all patients with diabetes in the practice) via scheduled visits and being available for real-time consultations during clinic hours. In the **consultant model**, physicians refer specific patients with complex medication issues or poor control to the pharmacist for a one-time or short-term consultation. Finally, the **population health manager** model leverages the pharmacist to use EHR data to identify care gaps across the entire patient population and conduct outreach to improve metrics like blood pressure or diabetes control at a system level [24]. The most effective practices often blend elements of these models.

5. Overcoming Barriers and Challenges to Implementation

Despite the compelling evidence, widespread implementation of physician-pharmacist collaboration in PHC faces significant barriers that must be strategically addressed.

Financial and sustainability challenges are often the most daunting. In many healthcare systems, there is a lack of sustainable funding mechanisms for pharmacists' clinical services. Fee-for-service physician payment models do not typically reimburse for team-based care, and pharmacists' cognitive services are often not recognized by public or private insurers. Creating viable payment pathways, such as direct billing codes for pharmacist-provided CMM, capitated payments that support team-based care, or value-based contracts that reward improved outcomes and reduced costs, is critical for long-term sustainability [25].

Professional and cultural barriers can also impede integration. Historical professional hierarchies and territorialism can lead to physician resistance, stemming from misconceptions about pharmacist competency, concerns over liability, or a perceived threat to autonomy. Conversely, some pharmacists may be hesitant to transition from a

dispensing-focused to a patient-care role due to training, confidence, or workflow habits. Overcoming this requires deliberate **interprofessional education** initiatives that foster mutual understanding early in training, as well as change management and leadership support within clinics to champion the new model and demonstrate its benefits [26].

Regulatory and legal variability creates a complex landscape. Scopes of practice for pharmacists, including their authority to prescribe (under protocol or independently), order laboratory tests, and administer vaccines, vary widely between and within countries. Restrictive regulations can severely limit the potential impact of the collaborative model. Advocacy for policy reform to align regulations with the evidence base and the evolving capacity of the profession is necessary to unlock the full potential of this partnership [27].

Operational and workflow integration presents practical hurdles. Allocating physical space in a busy clinic, integrating the pharmacist's schedule and documentation into existing workflows, and ensuring all staff understand and support the new role require careful planning and continuous refinement. Without this operational support, even a willing team can struggle to implement the model effectively [28]. A phased approach, starting with a pilot project focused on a single disease state, can allow for learning and adaptation before scaling up.

6. Future Directions and Conclusion

The future of physician-pharmacist collaboration in PHC is promising but demands continued evolution and strategic focus. Key directions include deeper **integration with digital health technologies**. Telehealth platforms can extend the reach of collaborative services to rural and underserved areas, while mobile health apps and remote monitoring devices (e.g., connected glucometers, blood pressure cuffs) can provide pharmacists with real-time data to monitor and adjust therapy proactively, facilitating a "high-touch" care model that is not solely dependent on in-person visits [29]. Expanding the focus to include **mental health chronic diseases**, such as depression and anxiety, represents another critical frontier, given the high prevalence of these conditions in primary care and the complex pharmacotherapy involved [30].

Furthermore, the model must adapt to manage **increasing multimorbidity and polypharmacy**. Future frameworks need to emphasize holistic medication reviews that consider deprescribing of potentially inappropriate medications, management of therapeutic competition, and alignment of complex regimens with patient goals and life expectancy. Pharmacists are ideally suited to lead this systematic approach to pharmacotherapy in patients with multiple chronic conditions [31]. Ultimately, the goal is the **mainstreaming of collaborative practice** as a standard of care for chronic disease management in PHC. This requires advocacy at all levels—educational institutions to prepare future practitioners for team-based care, healthcare organizations to create the necessary infrastructure, policymakers to design supportive payment and regulatory systems, and researchers to continue building the business case and refining best practices [32].

7. Conclusion:

In conclusion, the optimization of medication management for chronic diseases is a complex challenge that the traditional, fragmented healthcare model is poorly equipped to solve. Physician-pharmacist collaboration in primary health care offers a powerful, evidence-based solution. By combining distinct expertise within a coordinated, patient-centered team, this partnership demonstrably improves clinical outcomes, enhances patient safety and satisfaction, and provides cost-effective care. While barriers to implementation exist, they are not insurmountable. The path forward requires a concerted effort to create sustainable financial models, foster collaborative cultures, reform restrictive policies, and leverage new technologies. Investing in and scaling this collaborative model is not merely an optional improvement; it is an essential strategy for building the resilient, effective, and person-centered primary care systems needed to shoulder the growing burden of chronic disease worldwide.

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References

[1] Chambers DA, Glasgow RE, Stange KC. The dynamic sustainability framework: addressing the paradox of sustainment amid ongoing change. Implement Sci. 2013;8:117.

[2] Wang J, Wu H. Health shocks and Unbalanced Growth of Medical resources: evidence from the SARS Epidemic in China. Int J Health Serv. 2022;52:47–60.

[3] Klinga C, Hasson H, Andreen Sachs M, et al. Understanding the dynamics of sustainable change: a 20-year case study of integrated health and social care. BMC Health Serv Res. 2018;18:400.

[4] Wang X, Li C, Chen Y, et al. Relationships between job satisfaction, organizational commitment, burnout and job performance of healthcare professionals in a district-level health care system of Shenzhen, China Role ambiguity and role conflict and their influence on responsibility of clinical pharmacists in China. Front Psychol. 2022;13:992258.

[5] Damschroder LJ, Reardon CM, Opra Widerquist MA, et al. Conceptualizing outcomes for use with the Consolidated Framework for Implementation Research (CFIR): the CFIR outcomes Addendum. Implement Sci. 2022;17:7.

[6] Zhou Z, Zhao Y, Shen C, et al. Evaluating the effect of hierarchical medical system on health seeking behavior: a difference-in-differences analysis in China. Soc Sci Med. 2021;268:113372.

[7] GBD 2016 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990–2016: a systematic analysis for the global burden of Disease Study 2016. Lancet. 2017;390:1211–59.

[8] King DK, Shoup JA, Raebel MA, et al. Planning for implementation success using RE-AIM and CFIR frameworks: a qualitative study. Front Public Health. 2020;8:59.

[9] Zhang Q, Su H, Li B, et al. Physician-pharmacist collaborative management in patients after percutaneous coronary intervention: a retrospective propensity score matching cohort study. Int J Clin Pharm. 2022;44:90–9.

[10] Wu S, Tannous E, Haldane V, et al. Barriers and facilitators of implementing interventions to improve appropriate antibiotic use in low- and middle-income countries: a systematic review based on the Consolidated Framework for Implementation Research. Implement Sci. 2022;17:30.

[11] Yao D, Xi X, Huang Y, et al. A national survey of clinical pharmacy services in county hospitals in China. PLoS ONE. 2017;12:e0188354.

[12] Norton MC, Haftman ME, Buzzard LN. Impact of physician-pharmacist collaboration on diabetes outcomes and Health Care Use. J Am Board Fam Med. 2020;33:745–53.

[13] Xiao J, Wang Q, Tan S, et al. Analysis of patient medication compliance and quality of life of physician-pharmacist collaborative clinics for T2DM management in primary healthcare in China: a mixed-methods study. Front Pharmacol. 2023;14:1098207.

[14] Weiner BJ, Haynes-Maslow L, Kahwati LC, et al. Implementing the MOVE! Weight-management program in the Veterans Health Administration, 2007–2010: a qualitative study. Prev Chronic Dis. 2012;9:E16.

[15] Tu J, Liao J. Primary care providers' perceptions and experiences of family-centered care for older adults: a qualitative study of community-based diabetes management in China. BMC Geriatr. 2021;21:438.

[16] Means AR, Kemp CG, Gwayi-Chore MC, et al. Evaluating and optimizing the consolidated framework for implementation research (CFIR) for use in low- and middle-income countries: a systematic review. Implement Sci. 2020;15:17.

[17] Amin MEK, Nørgaard LS, Cavaco AM, et al. Establishing trustworthiness and authenticity in qualitative pharmacy research. Res Social Adm Pharm. 2020;16:1472–82.

[18] Moullin JC, Dickson KS, Stadnick NA, et al. Systematic review of the Exploration, Preparation, implementation, sustainment (EPIS) framework. Implement Sci. 2019;14:1.

[19] Dixon DL, Baker WL, Buckley LF, et al. Effect of a Physician/Pharmacist Collaborative Care Model on Time in Target Range for systolic blood pressure: Post Hoc Analysis of the CAPTION Trial. Hypertension. 2021;78:966–72.

[20] Saunders B, Sim J, Kingstone T, et al. Saturation in qualitative research: exploring its conceptualization and operationalization systematic review of the Exploration, Preparation, implementation, sustainment (EPIS) framework. Qual Quant. 2018;52:1893–907.

[21] Damschroder LJ, Lowery JC. Evaluation of a large-scale weight management program using the consolidated framework for implementation research (CFIR). Implement Sci. 2013;8:51.

[22] Yong FR, Garcia-Cardenas V, Williams KA, et al. Factors affecting community pharmacist work: a scoping review and thematic synthesis using role theory. Res Social Adm Pharm. 2020;16:123–41.

[23] Smidt SJ, Brophy T, Bi X, et al. Integrating policy to achieve a harmonized sustainability model: a multidisciplinary synthesis and conceptual framework. J Environ Manage. 2022;317:115314.

[24] Kang I, Urick B, Vohra R, Ives TJ. Physician-pharmacist collaboration on chronic non-cancer pain management during the opioid crisis: a

qualitative interview study. Res Social Adm Pharm Aug. 2019;15(8):1027–31.

[25] Wang N, Qiu S, Yang Y, et al. Physician-pharmacist collaborative clinic model to improve Anticoagulation Quality in Atrial Fibrillation patients receiving warfarin: an analysis of Time in Therapeutic Range and a Nomogram Development. Front Pharmacol. 2021;12:673302.

[26] Hunan Medical Security Bureau. Notice on new and revised pharmaceutical medical service price items: 2023.

[27] Paul B, Kirubakaran R, Isaac R, Dozier M, Grant L, Weller D. Theory of planned behaviour-based interventions in chronic diseases among low health-literacy population: protocol for a systematic review. Syst Rev Jun. 2022;21(1):127.

[28] Waltz TJ, Powell BJ, Fernández ME, et al. Choosing implementation strategies to address contextual barriers: diversity in recommendations and future directions. Implement Sci. 2019;14:42.

[29] Sun H, Saeedi P, Karuranga S, et al. IDF Diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. Diabetes Res Clin Pract. 2022;183:109119.

[30] Tan SL, Xiao J, Yuan HY, et al. Establishing and evaluating physician-pharmacist collaborative clinics to manage patients with type 2 diabetes in primary hospitals in Hunan province: study protocol of a multi-site randomized controlled trial in the era of COVID-19 pandemic. BMC Health Serv Res. 2022;22:299.

[31] Damschroder LJ, Aron DC, Keith RE, et al. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. Implement Sci. 2009;4:50.

[32] Hou Y, Tao W, Hou S, et al. Levels, trends, and determinants of effectiveness on the hierarchical medical system in China: Data envelopment analysis and bootstrapping truncated regression analysis. Front Public Health. 2022;10:921303.