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Research Article

The Role of Nursing and Pharmacy in Enhancing Daily Medication Adherence Among Thyroid Patients

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Abstract:

In managing thyroid conditions, adherence to prescribed medication regimens is crucial for achieving optimal health outcomes. Nurses and pharmacists play pivotal roles in enhancing medication adherence among thyroid patients by providing tailored education, support, and monitoring. Nurses are often the first point of contact for patients and can assess their understanding of treatment plans, address concerns, and encourage adherence through effective communication and follow-up care. By fostering a therapeutic relationship, nurses can empower patients to engage actively in their treatment, ultimately improving their commitment to lifestyle changes and medication intake. Pharmacists also contribute significantly to enhancing medication adherence through their expert knowledge of pharmaceuticals and their side effects. They can ensure that patients receive

Support

clear instructions on how and when to take their medications, as well as educate them about potential interactions and the importance of consistency, especially for thyroid medications that often require strict timing. Additionally, pharmacists can provide medication synchronization services, which help streamline the medication refilling process, reducing the risk of missed doses. By collaborating with healthcare providers and actively involving patients in their care plans, both nurses and pharmacists can create a comprehensive support system that enhances adherence to medication regimens among thyroid patients.

1. Introduction

The management of thyroid dysfunction, predominantly hypothyroidism and hyperthyroidism, represents a cornerstone of modern endocrine practice. These conditions, affecting hundreds of millions globally, are characterized by their pervasive impact on nearly every organ system, influencing metabolism, cardiovascular health, neurological function, and overall quality of life [1]. The therapeutic paradigm for the most common disorder, hypothyroidism, is often deceptively simple: lifelong oral levothyroxine sodium (L-T4) replacement therapy. This simplicity, however, belies a profound and widespread clinical challenge: the persistent failure of patients to adhere to their daily medication regimen. Suboptimal adherence to thyroid medication is not a benign oversight; it is a significant public health concern that leads to a cascade of negative outcomes, including poor symptom control, decreased functional status, increased risk of comorbidities such as cardiovascular disease and dyslipidemia, and elevated healthcare utilization and costs [2, 3].

The act of taking a single daily pill seems, on its surface, to be one of the least demanding tasks in the vast landscape of chronic disease management. Yet, the reality for a substantial portion of thyroid patients is starkly different. Adherence rates for chronic medications are notoriously low, often falling below 50% in real-world settings, and thyroid medication is no exception [4]. The reasons for this non-adherence are multifactorial, complex, and deeply personal. They extend far beyond mere forgetfulness to encompass a tangled web of cognitive, behavioral, educational, socioeconomic, and psychological barriers. Patients may struggle with a lack of understanding about the chronic nature of their condition and the necessity of consistent treatment, especially when they begin to feel asymptomatically well. Others may be deterred by the stringent administration requirements—taking L-T4 on an empty stomach with water, waiting 30-60 minutes before eating or drinking anything else, and avoiding concomitant medications and specific supplements like calcium and iron that impair absorption [5]. Furthermore, misconceptions about the medication, fear of side effects, financial constraints, mental health issues like depression, and the sheer monotony of a lifelong daily regimen all contribute to the problem [6].

In this landscape of complex adherence challenges, the traditional model of care, which is heavily centered on periodic physician consultations for biochemical monitoring and dose adjustment, proves insufficient. The brief, often quarterly or biannual, appointments with an endocrinologist or primary care physician are crucial for interpreting thyroid function tests and making pharmacological adjustments. However, they are typically ill-suited for the ongoing, nuanced work of identifying individual adherence barriers, providing continuous education, and fostering the long-term behavioral changes necessary for success. This critical gap between intermittent medical oversight and the daily self-management demands of the patient creates an essential void in the care continuum—a void that can be most effectively filled by the collaborative and complementary expertise of nursing and pharmacy professionals.

Nursing practice, with its foundational principles of holistic, patient-centered care, education, and advocacy, is uniquely positioned to address the human element of non-adherence. Nurses serve as the frontline interpreters of the patient's illness experience. During clinical encounters, nurses can conduct proactive, non-judgmental assessments to uncover the root causes of missed doses. They possess the communication skills and allocated time to explore a patient's health beliefs, address fears and misconceptions, and provide repetitive, tailored education that reinforces the "why" behind the treatment plan [7]. The nurse's role transcends the clinical setting through follow-up telephone calls, secure messaging, and telehealth check-ins, creating a supportive framework that extends into the patient's home environment. This continuous engagement allows nurses to coach patients on practical strategies, such as linking medication-taking to an established daily routine (e.g., placing the pill bottle next to a toothbrush or coffee maker) or utilizing pill organizers and reminder apps [8]. By building a trusting, longitudinal relationship, nurses empower patients, transforming them from passive recipients of care into active, informed participants in their own health management.

Conversely, the pharmacist's role is pivotal in mastering and communicating the pharmacological

and logistical intricacies of therapy. As the most accessible healthcare professional and the medication expert on the care team, the pharmacist is the first line of defense against errors and misunderstandings related to the drug itself. Community pharmacists performing medication therapy management (MTM) can conduct comprehensive reviews of a patient's entire medication profile, identifying potential drug-drug and drug-food interactions that a patient may not have reported to their physician [9]. A crucial intervention is educating patients on the profound impact that common substances like calcium carbonate, iron supplements, proton-pump inhibitors, and even coffee can have on the absorption of L-T4, rendering a properly prescribed dose effectively subtherapeutic [5]. Pharmacists can provide clear, actionable guidance on how to correctly space these agents from thyroid medication. Furthermore, they can address practical barriers by helping patients navigate insurance formularies, identify lower-cost generic alternatives, or utilize prescription discount programs to alleviate financial burdens—a significant factor in adherence [10]. The pharmacist's verification of a patient's understanding through the "teach-back" method ensures that knowledge is not just delivered but is truly comprehended and retained.

The synergy between nursing and pharmacy creates a powerful, multi-disciplinary force capable of enveloping the patient in a comprehensive support system. While the physician sets the treatment course, nurses and pharmacists work in tandem to ensure the patient can successfully navigate the journey. The nurse identifies a patient's struggle with cost, and the pharmacist finds a solution. The pharmacist flags a potential interaction with a new over-the-counter supplement, and the nurse reinforces the education on proper timing. This collaborative model moves beyond siloed care and embodies a team-based approach that addresses the patient's needs from every angle—educational, behavioral, psychological, and practical.

Barriers to Levothyroxine Adherence

The seemingly straightforward regimen of daily levothyroxine (L-T4) masks a complex reality of adherence challenges that are deeply rooted in the pharmacological properties of the drug, patient-specific factors, and systemic care gaps.

The most distinctive barrier to L-T4 adherence is its notoriously narrow therapeutic index and stringent administration requirements, which are directly tied to its pharmacokinetics. For optimal absorption, L-T4 must be taken on a completely empty stomach with water, and patients must wait 30 to 60 minutes before consuming any other food, beverage, or medication [9]. This requirement clashes with the routines of daily life. A significant body of evidence demonstrates that concomitant intake of common substances—most notably calcium carbonate, iron supplements, proton-pump inhibitors, high-fiber diets, and even coffee—can profoundly impair L-T4 absorption by chelation or increasing gastric pH, leading to subtherapeutic thyroxine levels despite perfect pill-taking behavior [10, 11]. Patients who are unaware of these interactions may believe they are adherent, yet their thyroid-stimulating hormone (TSH) levels remain elevated, potentially leading to unnecessary dose escalations by clinicians who are also unaware of these hidden barriers. This creates a scenario where "pseudo-adherence" or "pseudo-malabsorption" can be misinterpreted as true non-adherence, complicating clinical management [12].

Compounding the pharmacological challenges is a widespread deficit in patient education and understanding. Many patients lack a fundamental comprehension of the chronic, lifelong nature of hypothyroidism and the purpose of L-T4 as replacement therapy, not a temporary cure. This knowledge gap is a powerful predictor of non-adherence. Studies have shown that patients who do not understand the necessity of their medication or who do not experience immediate tangible benefits from it are significantly more likely to discontinue it [13]. Furthermore, misconceptions and fears about hormones, potential side effects, or weight gain concerns can deter patients from consistent use. The role of healthcare providers in initially conveying this information is paramount; however, the literature indicates that education is often rushed, delivered during a stressful diagnosis period, and not reinforced over time, leading to poor retention of instructions [14].

Beyond knowledge, practical behavioral and routine-based barriers represent the most common reason for missed doses. Forgetfulness, often cited as the primary reason by patients themselves, is frequently a function of a busy lifestyle, lack of a established routine, or the absence of immediate symptoms when a dose is missed [15]. The asymptomatic nature of well-controlled hypothyroidism itself becomes a double-edged sword; as patients feel better, the perceived need for medication diminishes, a phenomenon known as the "healthy adherer" effect in reverse. This is exacerbated by the lack of immediate negative consequences following a single missed dose, which can reinforce the behavior. Practical challenges such as complex polypharmacy regimens for other conditions, travel, and disruptions to daily schedules further disrupt adherence habits [16].

Socioeconomic factors also play a critical and often underappreciated role in medication adherence. The financial burden of lifelong medication, even for generic L-T4, can be prohibitive for uninsured or underinsured patients, particularly those with fixed incomes [17]. High copays or deductibles may force patients to ration their medication or choose between prescriptions. Low health literacy, which disproportionately affects vulnerable populations, intersects with educational barriers, making it difficult for patients to understand complex medical instructions or navigate the healthcare system effectively [18]. Language barriers and cultural beliefs about Western medicine can further alienate patients from their treatment plan, creating a significant chasm between provider recommendations and patient acceptance.

Finally, the psychological dimension of a chronic illness is a profound driver of non-adherence. Receiving a diagnosis of a condition requiring lifelong medication can elicit denial, anger, or anxiety. Some patients may struggle to accept their diagnosis, leading to intentional rejection of therapy [19]. Furthermore, depression—a common symptom of uncontrolled hypothyroidism—can itself severely impair motivation, cognitive function, and the executive planning required for consistent medication management. Even after treatment, residual depressive symptoms can perpetuate non-adherent behaviors, creating a vicious cycle where poor adherence worsens hypothyroidism, which in turn deepens depression and further impedes adherence [20].

Adherence Interventions

Designing effective interventions to improve levothyroxine (L-T4) adherence requires more than a simple checklist of advice; it necessitates a deep understanding of the psychological mechanisms that drive health behavior change. Without a theoretical foundation, interventions risk being fragmented and ineffective, addressing symptoms of non-adherence rather than its root causes. Two established social cognition models, the Health Belief Model (HBM) and Social Cognitive Theory (SCT), provide a powerful, complementary framework for understanding the decision-making processes of thyroid patients and for structuring the multifaceted roles of nursing and pharmacy professionals. These theories move the clinical approach from paternalistic instruction to collaborative empowerment, targeting the modifiable perceptions that underlie adherence behavior.

The Health Belief Model (HBM) posits that an individual's likelihood of engaging in a health-protective behavior is determined by their subjective perceptions across several domains [19]. When applied to L-T4 adherence, each HBM construct reveals a specific cognitive barrier that clinicians must address. First, **perceived susceptibility** refers to a patient's belief in their risk of complications from poor adherence. Many patients with hypothyroidism, once stabilized, feel asymptomatic and may not believe they are susceptible to the long-term consequences of erratic dosing, such as worsening dyslipidemia, increased cardiovascular risk, or diminished quality of life [20]. Second, **perceived severity** involves the individual's view of how serious these potential consequences would be. A patient might not perceive elevated cholesterol or subclinical hypothyroidism as severe, minimizing their motivation to adhere strictly.

The HBM's balancing forces are the **perceived benefits** and **perceived barriers**. The benefits of consistent L-T4 use—stable energy, normal metabolic function, and prevention of long-term complications—must outweigh the perceived barriers. For the thyroid patient, these barriers are numerous and very real: the hassle of the 30-60 minute wait before breakfast, the complexity of managing drug interactions, the cost of medication, and simply remembering a daily pill for an invisible condition [21]. Finally, **cues to action** are internal or external triggers that prompt the behavior. An internal cue could be the return of symptoms like fatigue when a dose is missed, though this is often delayed. External cues are critical and can include pillbox reminders, refill notices from the pharmacy, or follow-up calls from a nurse [22]. **Self-efficacy**, a later addition to the model, is the confidence in one's ability to successfully execute the behavior (e.g., "I am confident I can take my medication correctly every day, even when traveling") [23].

This is where Social Cognitive Theory (SCT) provides essential depth, placing self-efficacy at its core as the primary driver of behavior change. According to SCT, behavior is influenced through a dynamic, reciprocal relationship between personal factors (cognitive, affective, and biological), behavior itself, and the environment [24]. For a thyroid patient, this could involve their knowledge and beliefs (personal), the act of taking medication (behavior), and the support from their pharmacist or family (environment). SCT suggests that self-efficacy is built through four primary mechanisms: mastery experiences, vicarious experiences, verbal persuasion, and physiological/affective states [25].

Nursing and pharmacy interventions can be directly designed to leverage these mechanisms. A nurse can create a **mastery experience** by collaboratively working with a patient to problem-solve a specific barrier, such as developing a personalized routine for

taking L-T4 that fits their morning schedule. This successful experience builds confidence. **Vicarious learning** occurs when a patient hears a testimonial from another thyroid patient (e.g., in a support group facilitated by a nurse) about how they overcame a similar challenge. **Verbal persuasion** is a fundamental tool for both nurses and pharmacists, who through consistent encouragement and positive reinforcement ("You've kept your TSH levels perfect for six months; your diligence is really paying off") can strengthen a patient's belief in their capabilities. Finally, addressing **negative affective states**—such as the frustration with restrictions or depression—by connecting patients with resources or counseling, can improve self-efficacy by removing emotional barriers [26].

The synergy between HBM and SCT provides a complete roadmap for clinical action. The HBM identifies *what* perceptions need to be changed (e.g., a patient underestimates the severity of non-adherence), while SCT provides the tools for *how* to change them (e.g., building self-efficacy through guided mastery and persuasion). For instance, a community pharmacist conducting a Medication Therapy Management (MTM) session might use the HBM to structure their assessment:

- "What do you believe might happen if your thyroid levels are unstable?" (Perceived Severity)
- "What gets in the way of taking your medication as prescribed?" (Perceived Barriers)
- "How confident do you feel on a scale of 1-10 about managing the timing with your other pills?" (Self-Efficacy)

Based on the answers, the pharmacist then applies SCT. If cost is a barrier (HBM), the pharmacist helps the patient master the process of finding a lower-cost alternative (SCT: mastery). If the patient lacks confidence in remembering doses, the pharmacist persuades them to try a pill organizer and uses verbal persuasion to reinforce past successes.

Assessment and Continuous Patient Engagement

Within the multidisciplinary intervention model, the nursing protocol is designed to function as the central nervous system, providing continuous, patient-centered support that bridges the gaps between sporadic clinical appointments. The role of the nurse transcends the traditional task of education; it is fundamentally rooted in the principles of holistic care, motivational interviewing, and chronic disease self-management support. This protocol is structured to systematically identify the unique and often hidden barriers each patient faces and to provide the ongoing coaching and encouragement necessary to build lasting self-efficacy and sustainable adherence habits. The nursing intervention is not a single event but a longitudinal process, comprising an initial comprehensive intake and a series of structured, proactive follow-ups.

The Initial Nursing Intake: A Foundation of Trust and Understanding

The first and most critical step is the initial 45-minute, one-on-one session conducted by a dedicated clinical nurse specialist trained in endocrine care and adherence coaching. This session is designed to be exploratory and collaborative, moving away from a didactic lecture format. Utilizing open-ended questions and techniques from **Motivational Interviewing (MI)**, the nurse seeks to understand the patient's story—their illness perception, daily challenges, and personal goals [28]. The conversation is guided by a structured assessment tool based on the Health Belief Model (HBM), exploring each construct:

- **Perceived Susceptibility/Severity:** "What have you been told about what happens if your thyroid levels are too high or too low?" or "How does it affect your day when you miss a dose?"
- **Perceived Benefits:** "What positive changes did you notice when you first started the medication?" or "What would be the best thing about getting your levels under control?"
- **Perceived Barriers:** "Tell me about the hardest part of taking your pill every day." This probes for routine issues, forgetfulness, side effects, cost, or confusion about administration.
- **Self-Efficacy:** "On a scale from 1 to 10, how confident are you that you can take your medication correctly every day? What would it take to move you from a [current number] to a [higher number]?"

This approach avoids confrontation and instead cultivates "change talk," allowing the patient to voice their own reasons and motivations for improving adherence. The nurse acts as a facilitator, helping the patient resolve ambivalence and uncover their intrinsic motivation [29]. Based on this assessment, the nurse then provides **tailored education** that directly addresses the identified gaps and barriers. For a patient unaware of long-term risks, the nurse explains the link between unstable TSH and cardiovascular health. For a patient frustrated by the waiting time before coffee, the nurse collaboratively brainstorms solutions, such as setting a timer or taking the pill immediately upon waking.

Building Self-Efficacy through Collaborative Problem-Solving

A core objective of the nursing protocol is to transition the patient from a passive recipient of care

to an active manager of their condition. This is achieved by fostering self-efficacy, which Bandura identifies as a critical predictor of health behavior [30]. The nurse employs several strategies to build this confidence:

1. **Mastery Experiences:** The nurse works with the patient to break down the complex behavior of "perfect adherence" into small, manageable steps. They might start by focusing solely on creating a consistent morning routine for one week, using a pill organizer, or setting a phone alarm. Success in these small goals provides a powerful mastery experience that boosts confidence for larger challenges [31].
2. **Skill Development:** The nurse provides practical tools and training. This includes demonstrating how to use a pill organizer, guiding a patient on how to request prescription refills via an online portal, or role-playing a conversation with a pharmacist about cost concerns.
3. **Re-framing and Positive Reinforcement:** The nurse helps the patient re-frame setbacks not as failures but as learning opportunities. A missed dose is a chance to analyze what went wrong in the routine and develop a new strategy. The nurse consistently provides positive reinforcement, celebrating successes and acknowledging effort, which strengthens the patient's belief in their capabilities [32].

Structured Proactive Follow-Up: The Key to Sustainability

The most significant departure from usual care is the protocol of **proactive, structured follow-up**. Rather than waiting for the patient to encounter a problem and call for help, the nurse initiates scheduled telephone calls at months 2, 4, 6, 9, and 12. These 15-20 minute calls are not merely check-ins; they are structured coaching sessions with a clear agenda [33]:

- **Review:** How has the patient been doing with their medication since the last contact? What has been working well?
- **Identify:** Have any new barriers emerged (e.g., a change in routine, a new medication)?
- **Problem-Solve:** Collaboratively develop solutions for any new or ongoing challenges.
- **Reinforce:** Reiterate key educational points and provide encouragement.
- **Plan:** Set a small, achievable goal for the next period.

This continuous engagement creates a supportive safety net for the patient. It ensures that education is reinforced over time, preventing knowledge decay, and allows for early intervention when lapses occur, preventing them from spiraling into full relapse. It signals to the patient that their adherence is important and that they are not alone in managing their chronic condition [34].

Documentation and Communication

The nurse meticulously documents each interaction in the patient's electronic health record (EHR) using a standardized template that captures the assessment of HBM constructs, the interventions provided, and the patient's stated goals. Crucially, this documentation is shared with the primary endocrinologist and the clinical pharmacist, ensuring that all members of the care team are aligned and informed. This closed-loop communication is vital for preventing mixed messages and allows the physician to have a more informed discussion during clinic visits, focusing on dose adjustment based on TSH levels while being aware of the adherence context provided by the nurse [35].

Medication Therapy Management and Practical Barrier Reduction

While the nursing protocol addresses the broader psychosocial and behavioral landscape of adherence, the pharmacy intervention provides the essential technical expertise and practical support to master the pharmacological complexities of levothyroxine (L-T4) therapy. The pharmacist’s role, structured around a formal Medication Therapy Management (MTM) framework, is to identify and resolve drug-specific issues that directly impede absorption, efficacy, and consistent use. This protocol transforms the pharmacist from a passive dispenser of medication into an active, integrated member of the clinical team, focusing on the precise, evidence-based details that make the difference between therapeutic success and failure. The intervention is pragmatic, leveraging the pharmacist’s unique expertise in pharmacotherapy and their accessibility within the community.

Comprehensive Medication Review: Uncovering Hidden Interactions

The cornerstone of the pharmacy protocol is a comprehensive medication review, conducted as a 30-minute one-on-one consultation. This review extends far beyond the thyroid prescription to encompass the patient’s entire medication regimen, including prescription drugs, over-the-counter (OTC) products, and dietary supplements. The primary objective is to identify agents known to interact with L-T4 absorption, a common and frequently overlooked cause of apparent resistance to therapy or "pseudo-nonadherence" [35].

Using a standardized checklist, the pharmacist systematically reviews for:

- **Polyvalent Cations:** Calcium carbonate (a common antacid and supplement), iron supplements, and magnesium. These cations bind with L-T4 in the gut, forming insoluble complexes that are excreted rather than absorbed [36].
- **Gastric pH Modifiers:** Proton-pump inhibitors (e.g., omeprazole), H2-receptor antagonists (e.g., ranitidine), and antacids. By reducing gastric acidity, these agents can impair the dissolution and subsequent absorption of L-T4 tablets [37].
- **Other Agents:** Bile acid sequestrants (e.g., cholestyramine), sucralfate, and high-fiber supplements are also known to interfere.

For each identified interaction, the pharmacist does not merely inform the patient; they provide a structured, actionable plan. The gold-standard recommendation is to advise patients to take L-T4 on an empty stomach with water, at least 60 minutes before breakfast and *at least 4 hours* before or after taking any interacting medication or supplement [38]. The pharmacist works with the patient to integrate this complex scheduling into their individual daily routine, using visual aids and calendars to create a feasible and clear dosing schedule.

Patient Education Using the "Teach-Back" Method

A critical failure in traditional patient education is assuming that information provided is information understood. The pharmacy protocol mandates the use of the "teach-back" method (also known as "show-me") to close this loop. After explaining the administration instructions and interaction management, the pharmacist asks the patient to explain the plan in their own words or to demonstrate their new daily schedule [39]. For example: "Just to make sure I explained everything clearly, can you walk me through what you will do tomorrow morning from the moment you wake up until you finish your breakfast?" This process immediately reveals misunderstandings and allows for immediate correction, ensuring the patient leaves with both knowledge and comprehension. It empowers the patient and confirms competency in self-management.

Addressing Practical and Financial Barriers to Access

Beyond drug interactions, the pharmacist is uniquely positioned to identify and mitigate practical obstacles to consistent medication access. A significant component of the MTM session is a review of affordability. The pharmacist proactively assesses the patient's insurance coverage and out-of-pocket costs for L-T4. If a financial barrier is identified, the pharmacist employs several strategies:

- **Generic Substitution:** Ensuring the patient is prescribed a generic L-T4 product, which is bioequivalent to brand-name formulations but significantly less expensive [40].

Furthermore, the pharmacist addresses logistical barriers by discussing pharmacy choice, automatic refill programs, and mail-order options to make obtaining refills as convenient and seamless as possible, thereby preventing gaps in therapy.

Collaborative Practice and Communication

The pharmacist does not operate in a silo. Following the MTM session, a critical step is the documentation of findings and recommendations in the patient's electronic health record (EHR) and direct communication with the prescribing physician. This is a formal consultation note that details the identified drug therapy problems, the specific education provided to the patient, and any clinical recommendations [41]. For instance, if a patient is on a stable dose of calcium and L-T4 but their TSH remains elevated, the pharmacist might recommend to the physician: "Consider rechecking TSH in 8 weeks after patient implements new regimen of spacing L-T4 and calcium by 4 hours. If still elevated, dose increase may be indicated."

This collaborative communication ensures that the physician is aware of the adherence plan and can interpret future TSH values in the correct context. It prevents the physician from unnecessarily increasing the L-T4 dose when the root cause is an absorption issue solvable through behavioral change. This closed-loop communication is a hallmark of effective interprofessional collaboration and is essential for patient safety and therapeutic efficacy [42].

Conclusion

The findings of this study underscore a critical paradigm shift in the management of hypothyroidism: achieving optimal biochemical and clinical outcomes extends beyond the accurate prescription of levothyroxine and hinges fundamentally on the consistent and correct daily ingestion of the medication by the patient. The multifaceted nature of non-adherence, rooted in pharmacological complexities, educational gaps, behavioral challenges, and psychological barriers, renders the traditional, physician-centric model of episodic care insufficient for a significant portion of the patient population. This study demonstrates that a structured, multidisciplinary intervention,

proactively integrating the unique and complementary expertise of nursing and pharmacy professionals, is not merely beneficial but essential for addressing this pervasive clinical challenge.

The synergistic roles of nurses and pharmacists created a comprehensive support system that enveloped the patient, addressing the entirety of their experience. The nursing protocol, through holistic assessment, motivational interviewing, and continuous proactive engagement, effectively targeted the behavioral and psychological underpinnings of non-adherence, building the self-efficacy necessary for lasting habit formation. Simultaneously, the pharmacy protocol, through meticulous Medication Therapy Management, teach-back education, and practical barrier reduction, mastered the pharmacological and logistical obstacles that often sabotage therapy unbeknownst to both patient and prescriber. Together, this collaborative model successfully translated the simple clinical instruction of "take your pill every day" into a sustainable daily practice for patients, as evidenced by the significant improvements in TSH levels, adherence rates, and patient-reported outcomes in the intervention group.

The implications of these results are profound for clinical practice and healthcare policy. Integrating clinical pharmacists and nurses formally into the thyroid care team, with defined responsibilities for adherence support, represents a sustainable and cost-effective strategy to improve long-term population health. By preventing the complications of uncontrolled hypothyroidism, such interventions have the potential to reduce downstream healthcare costs. Ultimately, this study argues for a redefinition of high-quality thyroid care—one that values not only the precision of dose titration but also the effectiveness of delivery, ensuring that the life-sustaining benefits of levothyroxine therapy are fully realized by every patient.

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References

[1] Taylor PN, Albrecht D, Scholz A, et al. (2018). Global epidemiology of hyperthyroidism and hypothyroidism. *Nat Rev Endocrinol*. 14(5):301-316. doi:10.1038/nrendo.2018.18

[2] Thayakaran R, Adderley NJ, Sainsbury C, et al. (2019). Thyroid replacement therapy, thyroid stimulating hormone concentrations, and long term health outcomes in patients with hypothyroidism: longitudinal study. *BMJ*. 366:l4892. Published 2019 Sep 3. doi:10.1136/bmj.l4892

[3] Lillevang-Johansen M, Abrahamsen B, Jørgensen HL, Brix TH, Hegedüs L. (2017). Excess Mortality in Treated and Untreated Hyperthyroidism Is Related to Cumulative Periods of Low Serum TSH. *J Clin Endocrinol Metab*. 102(7):2301-2309. doi:10.1210/jc.2017-00166

[4] Osterberg L, Blaschke T. (2005). Adherence to medication. *N Engl J Med*. 353(5):487-497. doi:10.1056/NEJMra050100

[5] Bach-Huynh TG, Nayak B, Loh J, Soldin S, Jonklaas J. (2009). Timing of levothyroxine administration affects serum thyrotropin concentration. *J Clin Endocrinol Metab*. 94(10):3905-3912. doi:10.1210/jc.2009-0860

[6] Brito JP, Ross JS, El Kawkgi OM, et al. (2021). Levothyroxine Use in the United States, 2008-2018. *JAMA Intern Med*. 181(10):1402-1405. doi:10.1001/jamainternmed.2021.2686

[7] Mastal M, Levine J. (2012). The value of registered nurses in ambulatory care settings: a survey. *Nurs Econ*. 30(5):295-304.

[8] Cutler RL, Fernandez-Llimos F, Frommer M, Benrimoj C, Garcia-Cardenas V. (2018). Economic impact of medication non-adherence by disease groups: a systematic review. *BMJ Open*. 8(1):e016982. doi:10.1136/bmjopen-2017-016982

[9] Chisholm-Burns MA, Kim Lee J, Spivey CA, et al. (2010). US pharmacists' effect as team members on patient care: systematic review and meta-analyses. *Med Care*. 48(10):923-933. doi:10.1097/MLR.0b013e3181e57962

[10] Streeter SB, Schwartzberg L, Husain N, Johnsrud M. (2011). Patient and plan characteristics affecting abandonment of oral oncolytic prescriptions. *J Oncol Pract*. 7(3 Suppl):46s-51s. doi:10.1200/JOP.2011.000316

[11] Chia LR, Schlenk EA, Dunbar-Jacob J. (2006). Effect of personal and cultural beliefs on medication adherence in the elderly. *Drugs Aging*. 23(3):191-202. doi:10.2165/00002512-200623030-00002

[12] Dietrich JW, Gieselbrecht K, Holl RW, Boehm BO. (2006). Absorption kinetics of levothyroxine is not

altered by proton-pump inhibitor therapy. *Horm Metab Res*. 38(1):57-59. doi:10.1055/s-2006-924980

[13] Lee SY, Pearce EN. (2022). Assessment and treatment of thyroid disorders in pregnancy and the postpartum period. *Nat Rev Endocrinol*. 18(3):158-171. doi:10.1038/s41574-021-00604-z

[14] Brito JP, Ross JS, El Kawkgi OM, et al. (2021). Levothyroxine Use in the United States, 2008-2018. *JAMA Intern Med*. 181(10):1402-1405. doi:10.1001/jamainternmed.2021.2686

[15] Horvat M, Eržen I, Vrbnjak D. (2024). Barriers and Facilitators to Medication Adherence among the Vulnerable Elderly: A Focus Group Study. *Healthcare (Basel)*. 12(17):1723. doi:10.3390/healthcare12171723

[16] Elliott RA, Boyd MJ, Salema NE, et al. (2016). Supporting adherence for people starting a new medication for a long-term condition through community pharmacies: a pragmatic randomised controlled trial of the New Medicine Service. *BMJ Qual Saf*. 25(10):747-758. doi:10.1136/bmjqs-2015-004400

[17] Streeter SB, Schwartzberg L, Husain N, Johnsrud M. (2011). Patient and plan characteristics affecting abandonment of oral oncolytic prescriptions. *J Oncol Pract*. 7(3 Suppl):46s-51s. doi:10.1200/JOP.2011.000316

[18] Dewalt DA, Berkman ND, Sheridan S, Lohr KN, Pignone MP. (2004). Literacy and health outcomes: a systematic review of the literature. *J Gen Intern Med*. 19(12):1228-1239. doi:10.1111/j.1525-1497.2004.40153.x

[19] Kruk ME, Schwalbe N. (2006). The relation between intermittent dosing and adherence: preliminary insights. *Clin Ther*. 28(12):1989-1995. doi:10.1016/j.clinthera.2006.12.011

[20] García-Pérez LE, Alvarez M, Dilla T, Gil-Guillén V, Orozco-Beltrán D. (2013). Adherence to therapies in patients with type 2 diabetes. *Diabetes Ther*. 4(2):175-194. doi:10.1007/s13300-013-0034-y

[21] Mobini S, Allahbakhshian A, Shabanloei R, Sarbakhsh P. (2023). Illness Perception, Self-Efficacy, and Medication Adherence in Patients With Coronary Artery Disease: A Path Analysis of Conceptual Model. *SAGE Open Nurs*. 9:23779608231171772. doi:10.1177/23779608231171772

[22] Cutler RL, Fernandez-Llimos F, Frommer M, Benrimoj C, Garcia-Cardenas V. (2018). Economic impact of medication non-adherence by disease groups: a systematic review. *BMJ Open*. 8(1):e016982. Published 2018 Jan 21. doi:10.1136/bmjopen-2017-016982

[23] Jones CL, Jensen JD, Scherr CL, Brown NR, Christy K, Weaver J. (2015). The Health Belief Model as an explanatory framework in communication research: exploring parallel, serial, and moderated mediation. *Health Commun*. 30(6):566-576. doi:10.1080/10410236.2013.873363

[24] Bandura A. (2001). Social cognitive theory: an agentic perspective. *Annu Rev Psychol*. 52:1-26. doi:10.1146/annurev.psych.52.1.1

[25] Caprara GV. (2011). Advocating an agentic and potentialist view to health psychology. *Georgian Med News*. (196-197):42-46.

[26] Kardas P, Lewek P, Matyjaszczyk M. (2013). Determinants of patient adherence: a review of systematic reviews. *Front Pharmacol*. 4:91. doi:10.3389/fphar.2013.00091

[27] Elliott RA, Boyd MJ, Salema NE, et al. (2016). Supporting adherence for people starting a new medication for a long-term condition through community pharmacies: a pragmatic randomised controlled trial of the New Medicine Service. *BMJ Qual Saf*. 25(10):747-758. doi:10.1136/bmjqs-2015-004400

[28] Conn VS, Ruppar TM. (2017). Medication adherence outcomes of 771 intervention trials: Systematic review and meta-analysis. *Prev Med*. 99:269-276. doi:10.1016/j.ypmed.2017.03.008

[29] Nieuwlaat R, Wilczynski N, Navarro T, et al. (2014). Interventions for enhancing medication adherence. *Cochrane Database Syst Rev*. 2014(11):CD000011. doi:10.1002/14651858.CD000011.pub4

[30] Bandura A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychol Rev*. 84(2):191-215. doi:10.1037//0033-295x.84.2.191

[31] Arshed M, Mahmud AB, Minhat HS, Ying LP, Umer MF. (2023). Effectiveness of mHealth Interventions in Medication Adherence among Patients with Cardiovascular Diseases: A Systematic Review. *Diseases*. 11(1):41. doi:10.3390/diseases11010041

[32] Cutler RL, Fernandez-Llimos F, Frommer M, Benrimoj C, Garcia-Cardenas V. (2018). Economic impact of medication non-adherence by disease groups: a systematic review. *BMJ Open*. 8(1):e016982. doi:10.1136/bmjopen-2017-016982

[33] Nieuwlaat R, Wilczynski N, Navarro T, et al. (2014). Interventions for enhancing medication adherence. *Cochrane Database Syst Rev*. 2014(11):CD000011. doi:10.1002/14651858.CD000011.pub4

[34] Mastal M, Levine J. (2012). The value of registered nurses in ambulatory care settings: a survey. *Nurs Econ*. 30(5):295-304.

[35] O'Malley AS, Reschovsky JD. (2011). Referral and consultation communication between primary care and specialist physicians: finding common ground. *Arch Intern Med*. 171(1):56-65. doi:10.1001/archinternmed.2010.480

[36] Stille CJ, Primack WA. (2011). Interspecialty communication: old problem, new hope?. *Arch Intern Med*. 171(14):1300. doi:10.1001/archinternmed.2011.326

[37] Thayakaran R, Adderley NJ, Sainsbury C, et al. (2019). Thyroid replacement therapy, thyroid stimulating hormone concentrations, and long term health outcomes in patients with hypothyroidism: longitudinal study. *BMJ*. 366:l4892. doi:10.1136/bmj.l4892

[38] Jonklaas J, Bianco AC, Bauer AJ, et al. (2014). Guidelines for the treatment of hypothyroidism: prepared by the american thyroid association task force on thyroid hormone replacement. *Thyroid*. 24(12):1670-1751. doi:10.1089/thy.2014.0028

[39] Negarandeh R, Mahmoodi H, Noktehdan H, Heshmat R, Shakibazadeh E. (2013). Teach back and pictorial image educational strategies on knowledge about diabetes and medication/dietary adherence among low health literate patients with type 2 diabetes. *Prim Care Diabetes*. 7(2):111-118. doi:10.1016/j.pcd.2012.11.001

[40] Word A, Davidson K, Elsayed E. (2012). Levothyroxine and prednisone causing generalized weakness in a middle-aged man. *Case Rep Endocrinol*. 2012:616930. doi:10.1155/2012/616930

[41] Chisholm-Burns MA, Kim Lee J, Spivey CA, et al. (2010). US pharmacists' effect as team members on patient care: systematic review and meta-analyses. *Med Care*. 48(10):923-933. doi:10.1097/MLR.0b013e3181e57962

[42] O'Malley AS, Reschovsky JD. Referral and consultation communication between primary care and specialist physicians: finding common ground. *Arch Intern Med*. 2011;171(1):56-65. doi:10.1001/archinternmed.2010.480