

THE ISRAEL NATIONAL INSTITUTE FOR HEALTH POLICY RESEARCH**Final Report****Section 2: English Abstract****Full title of research project**

Implementing health information technology and integrated care for multimorbid patients

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Key Words

Multimorbidity, Integrated care, Health information technology

Abstract

(1) **Scientific background:** The co-occurrence of two or more chronic conditions in an individual is considered the "most common chronic condition" associated with substantial disability and high care costs. Health Information Technology (HIT) systems hold the potential to facilitate care for multimorbid patients.

(2) **Objectives:** (a) To map unique expressions of HIT use, which can support the provision of main aspects of care for multimorbid patients; (b) To examine through electronic health records (EHR) use the extent to which providers follow clinical recommendations; (c) To examine the coordination of care of patients and of HIT tools capabilities to overcome coordination challenges.

(3) **Methodology:** A mixed-methods design, incorporating qualitative and quantitative methods. *Qualitative Phase:* in-depth semi-structured interviews among primary care physicians and nurses. *Quantitative phase:* providers self-administered questionnaire, EHR data collection related to percentage of recommendations followed by health providers and patient questionnaires.

(4) **Findings:** Strengths of HIT systems included: the availability of a health information exchange system and the availability of a wide-range of sources of information, including prescription and dispensing of medications. Main challenges identified were: lack of efficiency in information retrieval, need to switch between multiple screens and simultaneously cope with multiple sources of information, and difficulties in coordinating among guideline recommendations and providers involved in the care of patients with multimorbidity.

(5) **Conclusions:** Findings point to the complexity of HIT use in care management of patients with multimorbidity. The findings are expected to be used to generate recommendations for the future evaluation research.

Section 3: Hebrew Abstract

כותרת מלאה של המחקר

הטמעת טכנולוגיות מחשוביות ואינטגרציה של הטיפול בחולה עם ריבוי תחלואה

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מילות מפתח

ריבוי תחלואה, אינטגרציה של הטיפול, טכנולוגיות מידע ממוחשבות

תקציר

תקציר שאורכו עד **200 מילים**, אשר יכלול כותרים אלה: (1) רקע (2) מטרות (3) שיטה (4) ממצאים עיקריים (5) מסקנות (6) המלצות / השלכות לקובעי המדיניות

(1) **רקע:** ריבוי תחלואה כרונית הוגדרה כמחלה כרונית שכיחה ביותר המתקשרת לסיכון להידרדרות ועלויות טיפול גבוהות. טכנולוגיות בריאות ממוחשבות (Health Information Technologies, HIT) טומנות בחובן פוטנציאל להקל על הטיפול בחולים עם ריבוי תחלואה. (2) **מטרות:** (1) לזהות את רכיבי ומאפייני השימוש העיקריים ב-HIT התומכים בטיפול בחולים עם ריבוי תחלואה כרונית; (2) למפות, דרך בחינת התייעוד בתיק הרפואי הממוחשב (EHR), את המידה בה מטפלים מבצעים המלצות טיפוליות; (3) להעריך את המידה בה מטפלים תופסים את הטיפול בהם כמתואם. (3) **שיטות:** מחקר משולב: שיטה איכותנית שכללה ראיונות חצי מובנים עם רופאים ואחיות, ושיטה כמותנית: שכללה איסוף נתונים באמצעות EHR, שאלונים למטופלים ולרופאים ואחיות. (4) **ממצאים עיקריים:** ממצאי המחקר מצביעים על מספר מגמות הקשורות לשימוש בכלים מחשוביים בתהליך ניהול הטיפול בחולים עם ריבוי תחלואה; כולל יתרונות, כגון המצאות מידע כוללני וכלים ליצירת אינטגרציה בין מטפלים ומערכות מטפלות. האתגרים העיקריים שזוהו: חוסר יעילות בשליפת מידע, צורך לעבור בין מספר מסכים ולהתמודד בו זמנית עם מקורות מידע מרובים, וקשיים בתיאום בין המלצות, הנחיות וספקים המעורבים בטיפול בחולים עם ריבוי תחלואה. (5) **מסקנות:** טיפול בחולים עם ריבוי תחלואה כרוך באתגרים רבים ושיפור כלים מחשוביים עשויים לסייע למטפלים במתן טיפול איכותי יותר. (6) **המלצות:** הממצאים צפויים לשמש לבניית המלצות לפיתוח, התאמה ושימוש שוטף בכלים של HIT.

Section 4: Executive Summary- Hebrew

(1) רקע מדעי: ריבוי תחלואה כרונית (Multimorbidity) מוגדר כקיום בו זמני של שתי מחלות כרוניות או יותר. חולים אילו נמצאים בסיכון מוגבר לירידה תפקודית, נכות, תחלואה אקוטית וצריכה גבוהה במיוחד של שירותי בריאות (Tinetti, Fried & Boyd, 2015). מורכבות הטיפול בחולים אלו קשורה במידה רבה לריבוי המטפלים ופרגמנטציה במתן שירותים (van de Akker, et al, 2019). על מנת לתת מענה לאתגרים אלה ולתמוך במתן טיפול אינטגרטיבי ורציף, מערכות בריאות מודרניות מטמיעות כלים מחשוביים. שלושה כלים מרכזיים הנמצאים בשימוש נרחב ברפואה ראשונית בשירותי בריאות כללית הם: 1. מערכת ה-"קליקס" - תיק רפואי ממוחשב (Electronic Health Record, EHR), המשמש כלי אחיד לכלל המסגרות והמטפלים בקהילה, ומאפשר אחסון מתמשך ושליפה זמינה של מגוון סוגי מידע רפואי ואישי אודות המטופלים; 2. מערכת "אופק" הינה מערכת להעברת מידע בין מסגרות מטפלות שונות (Health Information Exchange) הנגישה לכלל המטפלים ומאפשרת צפייה בנתוני רפואה ראשונית, מקצועית ומסגרות האשפוז; 3. "פורטל מחלות כרוניות – דרכון איכות" המיועד לתמוך בתהליך קבלת החלטות קליניות (Clinical Decision Support) על ידי הנגשת המלצות טיפוליות המתייחסות למצבים כרוניים נבחרים. כלים אלו נועדו לשיפור תהליכי ניהול ותיאום הטיפול, באמצעות הפחתת הפרגמנטציה ויצירת רצף טיפולי בחולים כרוניים. עם זאת, טרם נבדקה המידה בה מערכות ממוחשבות מספקות מענה לצרכי הטיפול בחולים עם ריבוי תחלואה, במיוחד בקרב רופאים ואחיות המטפלים בשיעור גבוה של חולים עם ריבוי תחלואה.

לצורך בחינה של השימוש בכלים מחשוביים במסגרת טפול בחולים עם ריבוי תחלואה, מחקר זה התמקד באוכלוסיית מטופלי שירותי בריאות כללית המקבלים טיפול אינטגרטיבי ע"י רופא ראשוני ואחות במספר מחלות כרוניות במרפאות ראשוניות, במסגרת תכנית "טיפול מכוון".

(2) מטרות המחקר: א. לזהות מאפיינים ספציפיים של הכלים המחשוביים אשר תורמים או מעכבים טיפול בחולים עם ריבוי תחלואה במסגרת תוכנית טיפול מכוון; ב. לבחון באיזו מידה המטפלים מיישמים המלצות טיפוליות לפי "דגשי טיפול" בניהול הטיפול בחולים במסגרת תוכנית

טיפול מכוון ואת התרומה של הכלים המחשוביים ביישום ההמלצות; ג. להעריך את תיאום הטיפול בקרב מטופלי טיפול מכוון ואת יכולת הכלים המחשוביים לתרום לתיאום הטיפול.

(3) שיטות המחקר: מחקר משולב (איכותני וכמותי). **המערך האיכותני** כלל ראיונות חצי מובנים בקרב רופאי משפחה ואחיות טיפול מכוון. הראיונות וניתוח הממצאים התבססו על מודל Health Information Technology Reference Based Evaluation Framework (HITREF) להערכת כלים מחשוביים במערכת הבריאות (Sockolow, Crawford, & Lehmann, 2012). **המערך הכמותני** כלל שלושה חלקים: א. איסוף מידע שיטתי באמצעות ה-EHR אודות יישום המלצות לטיפול וסיבות לאי יישומן; ב. שאלון טלפוני להערכת תיאום הטיפול, בקרב מטופלי טיפול מכוון אשר נערך 6 ו-12 חודשים מתחילת ההשתתפות בתוכנית; ג. שאלון דיווח עצמי להערכת אתגרי הטיפול בחולים עם ריבוי תחלואה ושימוש ב-EHR.

(4) הממצאים:

מטרה א': ראינו 4 רופאים ו-10 אחיות. 60 רופאים ואחיות השיבו על שאלון אתגרי הטיפול ושימוש ב-EHR. אנשי הצוות הצביעו על מגוון יתרונות בשימוש בכלים מחשוביים בניהול הטיפול בחולים עם ריבוי תחלואה כגון מבנה מידע מאוחד עבור המטפלים השונים ואף מסגרות טיפוליות שונות – דבר שמהווה יתרון בולט עבור המטפלים בחולים עם ריבוי תחלואה. לצד היתרונות המשמעותיים, המרואיינים הדגישו אתגרים/גורמים מעכבים הבאים: היעדר גישה והכשרה אחידה בשימוש ברכיבי ה-EHR, איכות מידע לא מספקת, מבנה מידע מבזר בהקשר למקורות מידע שונים וקושי באיתור המידע ושליפתו.

מטרה ב': בשלב זה נסקרו 204 תיקים של מטופלי טיפול מכוון, עם 21 המלצות בממוצע (ס"ת 5.4) למטופל וביצוע של 88% (ס"ת 9%) מההמלצות (34% עבור המלצות להתערבויות לא תרופתיות עד 98% מההמלצות לקידום אורח חיים). הסיבות העיקריות להיעדר יישום ההמלצות היו תופעות לוואי, אינטראקציות עם תרופות או מצבים אחרים, תנאים מורכבים (כגון קשיי ניידות עקב רגל תותבת) ומידע לא עדכני. רגרסיה לוגיסטית רבת משתנים הראתה כי גיל צעיר יותר והשתתפות למעלה משנה בתוכנית קשורים לסיכוי גבוה יותר ליישום ההמלצות תוך שליטה על מין ומספר

מחלות כרוניות. בממוצע, דליית מידע בנוגע ליישום המלצות ערכה כ-35 דקות (טווח 20-95 דקות).

מטרה ג': המדגם כלל 356 מטופלי טיפול מכוון. נמצא כי מטופלים מדווחים על אתגרים משמעותיים

בתיאום הטיפול בין כלל המטופלים שלהם, במיוחד בקרב מטופלים שנמצאים שישה חודשים או

פחות בתכנית.

(5) מסקנות: טיפול בחולים עם ריבוי תחלואה כרוך באתגרים רבים כולל המלצות טיפול כפולות,

סותרות או חסרות. במחקר הנוכחי זוהו כלים ייחודיים אשר מאפשרים או מעכבים מתן טיפול איכותי

לחולים עם ריבוי תחלואה. במיוחד, ממחקר זה בולט הצורך בכלים ליצירת אינטגרציה בין כלל

המלצות הטיפול וכלל הגורמים המטופלים. לצד היתרונות הבולטים לשימוש בכלים מחשוביים

מצטברות עדויות המתארות עומס משימות הנוצר בעקבות השימוש בכלים אלו, תופעה של "עודף

תזכורות" שהופך אותן ללא יעילות ואף שוחקות. לעתים המלצות טיפוליות ותזכורות אינן מותאמות

למטופלים באופן אישי למצב המטופל מה שמביא את המטופלים להתעלם מהתזכורות וכך עלול

לפגוע באיכות הטיפול (Fraccaro et al., 2015).

(6) השלכות למדיניות והמלצות למקבל ההחלטות: תוצאות המחקר צפויות לשמש לבניית

המלצות להתאמת רכיבי ה-EHR לטיפול בחולים עם ריבוי תחלואה במסגרת רפואה ראשונית.

(7) מקורות:

Fraccaro, P., Casteleiro, M. A., Ainsworth, J., & Buchan, I. (2015). Adoption of clinical decision support in multimorbidity: A systematic review. *JMIR Medical Informatics*, 3(1), e4.

Sockolow, P., Crawford, P., & Lehmann, H. (2012). Health services research evaluation principles. *Methods of Information in Medicine*, 51(2), 122-130.

Tinetti, M. E., Fried, T. R., & Boyd, C. M. (2012). Designing health care for the most common chronic condition—multimorbidity. *Journal of the American Medical Association*, 307(23), 2493-2494.

van den Akker, M. Vaes, B., Goderis, G., Van Pottelbergh, G., De Burghgraeve, T., Henrard, S. (2019) Trends in multimorbidity and polypharmacy in the Flemish-Belgian population between 2000 and 2015. *PloS one*, 14(2)

Section 5: Comprehensive scientific report - English

1. Scientific background

Multimorbidity, the co-occurrence of two or more chronic conditions in an individual is considered the "most common chronic condition" (Tinetti, Fried & Boyd, 2012) associated with substantial disability, higher incidence of acute illness and death, and contributes to the largest share of health care resource consumption.

Approximately one in four adults has two or more chronic conditions, and half have three or more chronic conditions (Fortin, Hudon, Haggerty, Akker, & Almirall, 2010). The prevalence of multimorbidity among individuals increases with age and is estimated to affect 35%-80% of the population in developed countries (Britt, Harrison, Miller, & Knox, 2008). Reported trends of increasing prevalence of multimorbidity (van de Akker, Vaes, Goderis, Van Pottelbergh et al, 2019) are highlighting the critical need to address the challenges related to the complexities involved in multimorbidity care management.

A major reason for the complexity in treating patients with multimorbidity is the discrepancy between current care management approaches, which are developed for single-disease care, and the features of multimorbidity. Single disease care recommendations are developed based on studies that exclude patients with multimorbidity and may have unintended consequences, by focusing providers' attention on specific aspects of care or care of single diseases instead of accounting for a full range of care activities that are relevant for patients with multimorbidity (DuGoff, Dy, Giovannetti, Leff, & Boyd, 2013). Despite the striking limitations of single-disease guidelines for patients with multimorbidity, little evidence has been generated to inform medical decision-making for patients with multimorbidity (Guthrie, Payne, Alderson, McMurdo, & Mercer, 2012).

Complexity in multimorbidity care is also due to the inherent fragmentation in healthcare delivery, with poorly integrated care systems and over-burdened healthcare providers. Providers often struggle with balancing the benefits and risks of multiple recommended treatments and following multiple recommendations is a challenge (Guthrie et al., 2012). Having more than one condition generates interactions between pathologies, duplication of tests, difficulties in adhering to often conflicting clinical practice guidelines, obstacles in the continuity and

coordination of care, confusing self-management information, and medication errors. In this context, Health Information Technology (HIT) hold a potential promise for multimorbidity care management as HIT systems are designed to handle complexity and support integration and longitudinal follow-up (de Lusignan, 2014).

Current healthcare delivery is characterized by increased adoption of HIT systems (Barbabella, Melchiorre, Quattrini, Papa, & Lamura, 2017). The most fundamental use of HIT in healthcare in general and in primary care in particular, is through Electronic Health Records (EHR) (Black et al., 2011). EHRs have been primarily developed for data management, including documentation, storage and retrieval of a wide variety of clinical data (such as diagnoses, treatments, laboratory tests, and medications) and nonclinical data (social and demographic characteristics) (Car et al., 2008). Many of the potential benefits of EHRs come from being able to collect and use large volumes of data relatively quickly at any point of care (Black et al., 2011; Krist et al., 2014). Yet, data collection and retrieval are only the foundation functions of current advanced EHR systems and a wide array of aspects related to how EHRs are used in current practice are increasingly developed and identified (Ancker et al., 2014). Data organized within the EHR is easily presented at subsequent encounters, can be used to support clinical decision making, via Clinical Decision Support (CDS) systems and can potentially be transferred between providers and care settings using Health Information Exchange (HIE) mechanisms.

While CDS systems hold the potential for improving care processes, their implementation within multimorbidity care management settings is not known. A recent review has found that only 4 of the 50 studies focused on merging concurrent clinical practice guidelines and all systems described tended to simplify the analysis by referring to only two concurrent clinical practice guidelines (Fraccaro et al., 2015). Yet, this scenario is too simplistic for the current reality of multimorbidity, as patients often have more than two concurrent conditions.

HIEs are defined as interoperable electronic sharing of clinical information among health care providers (Bailey et al., 2013), allowing access to patient data to inform decisions, and thus potential to reduce fragmentation of care (Rudin, Motala, Goldzweig, & Shekelle, 2014). As more types of information become more readily

available through HIE the potential for improved coordination and continuity increases, yet, use of HIE is almost uniformly low and many barriers to its efficient use exist (Flaks-Manov, Shadmi, Hoshen, & Balicer, 2016; Hersh et al., 2016). Thus, understanding how HIE can best address the challenges related to multiplicity of information generated by a wide range of providers across multiple care settings, involved in the care of patients with multimorbidity, is needed.

In Israel's Clalit Health Services, the EHR system ("Clicks") is a commercial electronic product which serve as the sole tool for documenting medical information under a range of circumstances and work environments across all the organization's primary care clinics (Fragidis & Chatzoglou, 2018). The Clicks system includes elements of data management (intake, storage and retrieval), including data on all prescriptions and dispensed medications, lab tests and imaging and specialist consultations. Additional HIT platforms and tools in use are the HIE system - "OFEK" and CDS embedded within the Clicks, such as the "chronic disease portal" (has been implemented in Clalit since 2005) (Nirel et al., 2010). Nonetheless, the potential of EHRs in relation to their ability to support the delivery of comprehensive and coordinated care for patients with multimorbidity is yet to be evaluated.

Evaluation of HIT use has generally focused on technology implementation and user satisfaction. Few studies are guided by conceptual models that help map the various HIT aspects that should be evaluated. One such framework is the Health Information Technology Reference Based Evaluation Framework (HITREF) model (Sokolow, Crawford, & Lehmann, 2012). The model was previously used in studies which reviewed various HIT evaluation frameworks to develop recommendations and guidelines for HIT assessment and HIT users' satisfaction (Gray & Sokolow, 2016; Haux & Lehmann, 2014). HITREF systematically extracts six HIT concepts to guide research and evaluation of EHR use in different medical contexts, including one that pertain to the structural aspects: *structural quality*; two that pertain to the processes of using the technology: *quality of information logistics* and *effect on quality of care processes*; two that pertain to outcomes: *effects on outcomes of quality of care* and *unintended consequences/benefits*; and a sixth general aspect that relates to general *barriers and facilitator* (Figure 1 in Appendix).

As part of organizational efforts to better integrate the care of patients with multimorbidity, Clalit Health Services has recently begun to implement the Comprehensive Care for Multimorbid Adults Program (CC-MAP). The CC-MAP is based on the Guided Care program developed in the US (Boyd et al., 2007) introducing a new role for nurses working jointly with the patient's primary care physician, to perform several care activities aimed at improving the care of patients with multimorbidity who are at high risk for deterioration and high resource use. These activities include the performance of a comprehensive assessment, creation of a tailored care plan, based on all recommendations from existing clinical guidelines for each of the patient's conditions, proactive follow-up, self-management support and caregiver support and care coordination. A major innovation of the CC-MAP is the implementation of abbreviated practice guidelines aimed to highlight care recommendations for 9 high impact and high prevalence chronic conditions - congestive heart failure, chronic obstructive pulmonary disease, chronic kidney disease, diabetes, hypertension, depression, atrial fibrillation, ischemic heart disease, and dyslipidemia. These abbreviated guidelines serve as the basis for the development of a patient tailored care plan by the primary care physician and CC-MAP nurse, which guides patient care decisions and is translated to specific actionable tasks the patient is supported in performing (such as lifestyle changes or improving adherence to medications).

Throughout the implementation of the CC-MAP various tools have been incorporated to the Clalit EHR platform and to the workflow processes of CC-MAP nurses. This study aimed to assess the HIT related needs of primary care teams, providing care for patients with multimorbidity and to assess the degree HIT tools support the ability of primary care nurses and physicians to provide high quality care for patients with multimorbidity, including: (1) the presentation of relevant clinical data, tailored to the need of patients with multimorbidity; (2) the implementation of clinical guidelines for multi-morbid patients; and (3) the prioritization of patients according to their complexity and the urgency of care.

2. Research Objectives

The main objective of this study is to examine the whether the needs related to the use of integrated HIT tools in the care of patients with multimorbidity and to assess

the degree to which they lead to better coordination and improved quality of care through the support for performance of guideline concordant care.

The specific aims are:

1. To identify HIT features that contribute or hinder care management for multimorbid patients within a primary care management program (the CC-MAP)
2. To examine the extent to which providers make recommendations according to a set of clinical guidelines tailored for the care of patients with multimorbidity and the potential contribution of HIT features to support performance of multiple care recommendations.
3. To examine the coordination of care of patients within the CC-MAP program and to assess HIT tools capabilities to overcome coordination challenge

3. Methodology

Setting

This study evaluated care provided as part of Clalit's CC-MAP. Patients eligible for the program are adults (age 18 or older) who have 3 or more chronic conditions and who were identified by a morbidity burden prediction model (the Johns-Hopkins Adjusted Clinical Groups Predictive Model – ACG-PM) (Balicer et al., 2010) as patients at high-risk for deterioration in their overall health condition and for incurring high future costs. Upon entrance to the program patients undergo a comprehensive assessment and a care plan is produced based on relevant clinical guidelines, as detailed above. Only primary care clinics in which physicians have an overall high or very high morbidity burden of their patient panel (i.e., a large percentage of high risk multimorbid patients) are eligible for participation in the CC-MAP. The program is recently gradually implemented within Clalit's clinics, with a case load of 150 patients for each CC-MAP nurse.

Study Design

A mixed-methods design, incorporating qualitative and quantitative methods.

Qualitative Phase – in-depth semi-structured interviews were performed among primary care physicians and CC-MAP nurses.

Quantitative phase – this phase included three main parts:

1. Data were collected on patients participating in the CC-MAP on performance of care processes according to guideline recommendations via electronic health

record data retrieved by participating CC-MAP nurses. Data on guideline non-concordance was assessed and reasons related to gaps in information were identified. The relations between patient and CC-MAP care characteristics were assessed.

2. Patients' assessment of the degree to which their care is coordinated was collected via patient-reported telephone questionnaires at two time points: at 6 month and 12 months after initiation of participation.

3. Providers' (nurses' and primary care physicians') assessments of challenges related to multimorbid care management and HIT use were collected via a self-administered questionnaire.

Study population

Healthcare providers: Primary care physicians and nurses in Clalit medium-large primary care clinics in various locations around the country (Haifa, North, Tel-Aviv, and Central regions), providing care for a large (at least 15% of the practice) percent of multimorbid patients, were invited to participate in the semi-structured interviews. Inclusion criteria were: physicians and nurses with at least 3 year experience in primary care clinics, caring for patients with multiple chronic conditions. Additionally, the questionnaire was administered to all physicians and nurses who participate in the CC-MAP.

Patient population: Patients eligible for the CC-MAP are those with an overall morbidity risk score (ACG system high risk probability score) of 0.19 or above (corresponding to 4% Highest Risk Score), are age 18 and older, and who have 3 or more chronic conditions. The CC-MAP does not include patients who are confined to bed, are kidney, liver or heart transplant patients, patients receiving active cancer treatment (chemotherapy, radiotherapy or other oncology treatment during the past 3 years), dialysis patients, patients with schizophrenia and patients who are cognitively impaired. Patients whose records were reviewed as part of this study include only those with at least 2 of the focus conditions for which a minimal set of guideline recommendations was developed: congestive heart failure, chronic obstructive pulmonary disease, chronic kidney disease, diabetes, hypertension, depression, atrial fibrillation, ischemic heart disease, except for dyslipidemia (as it is sometimes considered a pre-condition). Diagnoses were extracted from the Clalit

database and confirmed by the nurse during the patient file review. Patients were sampled based on either being: new to the CC-MAP (≤ 6 months in the CC-MAP), or veteran to the program (≥ 1 year). Of the 295 patients that were eligible for the study, records were reviewed for 204 patients (until sample size requirements were met).

Data collection framework and instruments:

Qualitative phase: *HIT interviews* were guided by the HITREF framework described above. Semi-structured interviews of ~45-60 minutes were conducted with primary care physicians and CC-MAP nurses, in purpose to elicit more information about clinicians' perceptions about the appropriateness of HIT to meet the needs related to multimorbidity care management, specifically the provision of coordination of care.

Quantitative phase

Challenges to multimorbidity care management and HIT use - Physicians and nurses were asked to rate the following: (a) How often do you encounter the following for your multimorbid patients (i.e. patients who have multiple chronic conditions)? and (b) To what degree does the EHR system ("Clicks") support provision of care for patients with multimorbidity? Answers were rated on a 5-point Likert type scale ranging from 1= "not at all" to 5= "a lot".

Percentage of recommendations followed by health providers - Summary measures of the percentage of recommended guidelines being followed by providers were constructed based on electronic health record information on providers' referrals to recommended tests, procedures, and specialty visits. All follow-up laboratory tests and imaging which were ordered, and all referrals and procedures that have been made as indicated in the care recommendations for each of the relevant conditions of the 9 focus conditions were recorded. For each patient a score was calculated, based on the proportion of care processes referred or provided by the physician or nurse, out of total relevant recommendations. The score was then dichotomized at the mean score, with 0 = "below average guideline concordance" and 1 = "at or above average guideline concordance" (see Appendix 2 for an example of the abbreviated guidelines developed for the CC-MAP for one of the nine conditions: Chronic Obstructive Pulmonary Disease (COPD) and of the coding scheme for the percentage of referrals performed). Additionally, for care processes which were not recommended or referred

to, nurses were asked to provide reasons out of a predetermined category list (e.g., biomedical reasons, such as no clinical need or patient has a physical or cognitive limitation).

Coordination of care – was assessed via patient questionnaires on their experience with aspects related to their chronic illness care (using subscales of the Patient Assessment of Chronic Illness Care (PACIC) questionnaire (Glasgow et al., 2005). The PACIC is a validated questionnaire, which provides a patients' self-assessment measure of their care experience. The instrument has been translated, validated and used by patients with various conditions in several countries, including in a sample of Israeli Heart Failure patients. The "coordination" subscale includes 5 items (Cronbach's $\alpha = .844$). Example of items: "Referred to a dietitian, health educator, or counselor"; "Told how my visits with other types of doctors, like an eye doctor or other specialist, helped my treatment".

Data Analysis

Qualitative phase – The analysis encompassed the concurrent processes of collecting, coding, categorizing, and interpreting interview data (Strauss & Corbin, 1990). First, two researchers coded the transcribed text. During this process, we grouped relevant statements into themes, following the iterative procedures recommended by Hall and colleagues (Hall, Long, Bermbach, Jordan, & Patterson, 2005). Discussions between the coders and other members of the research team continued until consensus was reached. Finally, themes were proposed and, relationships among categories were examined and described.

Quantitative phase – Descriptive statistics were used for the providers' and patients' questionnaires. Bivariate analyses included t-tests for continuous variables and chi-square for categorical variables. A p-value smaller than 0.05 was considered for statistical significance. Following the above preliminary stages multivariate linear regression was performed to estimate the relationship between the guideline concordance and characteristics of patients and of CC-MAP care. Analyses were performed using SPSS (version 25) and STATA (version 10).

4. Findings

Findings for Aim 1:

Qualitative

Interviews were conducted among 14 staff members in, including 4 physicians and 10 nurses. Eight nurses had an MA degree and 2 had a BA. Seniority within primary care or other community settings ranged between 10-35 years. Analyses focused on the structure and process categories of the HITREF model: *structural quality*; *quality of information logistics* and *effect on quality of care processes*. Classification of themes and subthemes followed the main constructs of the HITREF model as outlined below:

Structural Quality (Functionality)

All the interviewees work on a regular basis with a standard EHR used by Clalit Health Services ("Clicks"). Nurses and physicians work with similar versions of the patient's EHR, each slightly customized in terms of the organization of tools which are used by each profession (for example, nursing assessments are not displayed at the front page of the physicians' view). Functionality according to the HITREF model refers to the ability of the structural elements of the HIT to support its main functions. The following sub-categories emerged as central to how nurses and physicians use the EHR in caring for multimorbid patients.

Mastering EHR use: lack of a systematic approach

One of the challenges of caring for patients with multiple chronic conditions is the need to handle many pieces of information (many medications, a large variety of lab tests and consultations, etc.) and to cope with the various types of alerts and tools available in the EHR. According to our interviewees this requires a relatively high level of mastery of the EHR, yet training even in basic EHR use was not standardizes and there was significant variation in how each provider used the EHR. Noteworthy was the fact that there was no systematic approach to how the EHR should be used in the course of care for patients with multimorbidity (e.g., when a care plan is made, which screens should be viewed, where should what type of information be documented).

Fragmented structure: technical delays and frustration

Navigation within the Clicks and between the Clicks and other HIT tools such as the OFEK HIE system was reported as not streamlined well which causes many delays and frustrations. Also, as patients with multimorbidity has a lot of information on their conditions generated by different providers and care settings, this poses a significant burden in terms of the time it takes to review all of the relevant information. Additionally, sometimes there are delays in information flow, especially as the hospitalizations admission information is not always up-to-date. This can contribute to fragmentation as, for example, if a patient is discharged yet they still appears in the "currently hospitalized" list, there is a missed opportunity for post-discharge follow-up.

Structure in the service of integration

Several features available in Clalit's HIT systems serve to promote integration between providers, settings and clinical recommendations. The HIE system, the OFEK connects information from patients' EHR from primary care, specialists and hospital settings and enables providers to view patients' information on diagnoses, lab tests, and imaging.

The following HIT tools were reported as contributing to multimorbid care management, especially as they contribute to integration: the "chronic disease portal", which combines alerts on common chronic conditions (Diabetes, congestive heart failure, hypertension, chronic kidney disease and hyperlipidemia) and notifies the nurse whether clinical guidelines (also termed as "quality indicators") for any of these conditions are not met; "similar EHR": the ability of nurses to view the same information available at the physicians' version of the EHR and vice versa; and "team communication" including a messenger service between the primary care physicians and the nurses, and shared notes. Nurses indicated that these tools promote their ability to integrate amongst the various sources that take part in the care of patients with multimorbidity.

One structural aspect that is missing but was indicated to be highly needed by the nurses is a tool that enables to plan the patients' visit schedule ahead of time. As planned follow-up is an important feature of chronic care management, especially when patients have many conditions and many aspects of care are in

need of follow-up (medication adherence, recommendations for life-style changes, specialist consultations etc.), lack of such tools hinders continuity and integration.

Effect on Quality Processes

Appropriateness of patient care - The tension between standardized processed data and flexible clinical decision making

EHR systems are usually mostly developed for documentation and management of single diseases and episodes of care. HIT tools that are aimed at ensuring the completion of quality indicators (originally developed for single chronic conditions) are usually incompatible with the need to integrate amongst multiple recommendations and considerations, such as conflicts and contraindications between medications and treatments or care burden for patients. As the physicians and nurses who were interviewed noted, there is an inherent tension between the standardized approach aimed to promote quality of care and make sure important care recommendations are not missed, to the need for flexibility in order to tailor the treatment plan to meet the needs of patients with multimorbidity.

Quality of Information logistics

Completeness and correctness of data

One of the major challenges related to EHR use of patients with multimorbidity which was noted by our interviewees is the need to maintain an orderly problem list which includes all the current diagnoses without omissions and duplications.

Physicians and nurses have noted that for patients with several chronic conditions, for which diagnoses are generated by various physicians (either the primary care physician or the various specialists), managing the problem list requires time and awareness to what was recorded by whom and when.

Table 1: Themes and subthemes

Category	Sub-theme	Example Quotes
Structural Quality: Functionality	Mastering EHR use: lack of a systematic approach	#2 nurse: <i>"In fact, I received training on how to use the Clicks as an apprentice in the clinic, from a veteran nurse in the clinic, and then every time there were updates, there were emails with explanations about how to employ them, or maybe there were lectures here and there "</i> #15 physician: <i>"We are working with software that was constructed 20 years ago to meet the needs of pharmacists. It is not originally intended for you by</i>

Structure in
the service of
integration

physicians and nurses, and its definitely not intended for use in chronic illness care. " "... every doctor or other staff member is trained at some point. There is no basic training and each staff member's needs are different. There are really a lot of fields and screens and you can also do the same job in a different way."

#3 nurse: "After I listen to the patient, I also check what happened on our previous visit, what we did, what topics we talked about, if I provided any consultation or new information, I go through all these things ...I check specialist consultations, if he [the patient] performed some tests during this time, .. it is more or less the process... there is no "one-way""

#8 nurse: "the doctor asked me all kinds of questions, I told him, everything is available on OFEK, all her follow-ups and all her tests appear there"

#2 nurse: "the "chronic disease portal" and the "quality passport" enable me to jointly view all quality indicators that were not completed for this patient. Not all are relevant for the patient but I have an option to indicate what is not relevant" "...another very useful new addition to the Clicks is the medication adherence management screen – there I see all the prescribed medications with non-dispensed drugs marked in red, which I can follow-up on and see why the patient is not taking and if changes are need to be considered by the doctor. "

#3 nurse: "the doctor and I see the same information and this is very important because I'm not dependent on receiving information from the doctor. We usually communicate via the "messenger" I send him a short question or ask him to open the patient's record and look at the patient's test results"

#5 nurse: "I invite the patient for follow-up and document in the system that this is a planned visit. On the day of the visit, I will receive a reminder of all the patients who have planned visits that day. There is also a reminder about diabetes and blood pressure monitoring. There is also a possibility to place a reminder in my personal work calendar, but I do not use it because I have too many reminders. There is no mechanism for planning the schedule for all of my patients in a predetermined way for the next week or month."

Fragmented structure: technical delays and frustration	#5 nurse: <i>"The patient tells me I was at the doctor's office and I have not seen the visit yet, so I'm looking in the OFEK where it's not straightforward, because if I open the OFEK it takes a while before it opens and then if I need additional information on the patient, I have to go back to the Clicks, close OFEK, which cannot stay open on my end and then go from screen to screen, which is very cumbersome."</i> #15 physician: <i>"There is no possibility of smooth transition between screens, parallel work, flexibility in presentation. For example, now I want to go through the medications. I want to see diagnoses and lab test results. How can I remember some of the values of HbA1C and fasting glucose, and both kidney function ... So I close and open again and again. Sometimes 5 times I go back to the lab instead of minimizing the screen or placing in parallel. Feels like I'm working inefficiently"</i> #13 physician: <i>"in the EHR we receive a notice if the patient is hospitalized and if he was discharged, yet sometimes there are delays, I get a phone call from the patient, he tells me that he's at home but according to the system he's in the hospital".</i> #2 nurse: <i>"If there is a patient who has diabetes, and also hypertension and he is home bound with a foreign worker, then the follow-up times are different, the computerized assessments are different, there are a lot of assessments needed and sometimes it takes an hour and a half to complete"</i>
Effect on Quality Processes	Appropriateness of patient care - The tension between standardized processed data and flexible clinical decision making #15 physician: <i>"In treating patients with multimorbidity, we usually deal with metabolic diseases and blood vessels. Combinations are what is important. It is important to note the conflicts between the drugs or the recommendations. All these areas need to be processed, analyzed, and expressed during treatment. At the moment, this processing is happening only in my head"</i> #8 nurse: <i>"I feel that it limits my ability to think, ... I rely too much on selection options and standard indicators.. and it's sad and that's how it works, it does not stimulate us anymore the brain to think a bit beyond"</i>

Quality of Information logistics	Completeness and correctness of data	#6 nurse: <i>"There is often a big mess in how the problem list is organized. There are outdated diagnoses, duplications and sometimes omissions. These patients have a lot going on and the physician doesn't have time to organize and check and delete diagnoses that are not relevant any more."</i> #13 physician: <i>"there are many sources where information is written. If you want to know what is going on, you need to go over every diagnosis to see when they [the specialists] wrote it, go in the record to see why they wrote it, who wrote it, many times it was just for see and reassure"</i> #11 physician: <i>"For example, it is documented that the patient has hypertension and no one has measured his blood pressure. Once it was measured, and since then he has had this diagnosis. If I decide now that for every patient I will go on and correct the diagnoses, I will not sleep for a week ... And it gets messed up very quickly back again"</i>
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Quantitative

Providers' (nurses' and primary care physicians') assessments of challenges related to multimorbid care management and HIT use were collected via a self-administered questionnaire. A total of 37 nurses and 23 physicians participated in the survey, with a median of 20 years in the profession, 7 years in the primary care clinic, and medium-high levels of perceived challenges related to multimorbid care management (M=3.5, SD=0.5), (M=3.6, SD=0.7) and HIT use (M=3.2, SD=0.7).

Tables 2a-b presents the distribution of each item for each of the scales.

Table 2a: Perceived challenges related to multimorbid care management

Item	Mean (SD)
Contra-indications of medications	3.1 (1.0)
Contradiction in other guidelines for two or more conditions	3.0 (0.9)
Incompatibility of clinical guideline target levels (e.g. LDL <100, HbA1c <7) indicated in guidelines relative to what you think is appropriate	3.3 (0.9)
Treatment and follow up guidelines are not aligned with the targets of care you think are appropriate	2.9 (1.0)
Treatment guidelines are not aligned with patient preferences or priorities	3.6 (0.9)
Medication guidelines are too complex to adhere to	3.8 (0.9)
Self-care regimens (e.g., self monitoring) for multiple conditions are	3.9 (0.8)

too complex and/or contradictory for patient to follow	
Follow up and tests guidelines are too difficult to be done	3.7 (0.8)
It is difficult for patients to comprehensively understand the guidelines	4.0 (0.9)
It is difficult for patients to meet all care requirements due to economic constraints	3.5 (1.0)
It is difficult for patients to coordinate their care and referrals	3.8 (0.9)

Items that were rated highest indicate the complexity of medication and self care regimens, and care coordination. Items that were rated lowest relate to the compatibility between the guidelines and patient specific targets of care and contradiction among guidelines for several conditions.

Table 2b: Perceptions regarding the degree to which EHR features support multimorbidity care management

Item	Mean (SD)
Provides comprehensive information on all patient health conditions	3.6 (0.7)
Enables integration of all guidelines for all health conditions	3.0 (1.0)
Supports achieving Clalit's quality goals	3.6 (0.7)
Provides an up-to-date snapshot of all patient health conditions	3.4 (0.8)
Allows flexibility in adapting care to patient with multimorbidity	3.1 (1.0)
Allows intervention planning for patient with multimorbidity	3.0 (1.0)
The information is displayed clearly	3.3 (0.9)
Enables efficient information exchange between providers (consultants)	3.3 (1.0)
Enables efficient information exchange between medical records and nursing records	3.2 (1.1)
Enables efficient information exchange between primary care and hospital settings	3.2 (1.0)
Enables integration of guidelines from all providers	2.7 (1.0)
Provides tools to support patient self-care and monitoring	2.9 (0.9)
Allows to take into consideration clinical aspects when planning patient's care	3.2 (1.0)
Provides alarms/reminders according to care needs	3.0 (1.0)
Provides information on abnormal results (laboratory and other)	3.3 (0.9)

Items that were rated highest indicate the EHR provides comprehensive information on all patient's conditions and supports achieving Clalit's quality goals. Items that were rated lowest relate to integration of guideline and self-care support. On average, no significant differences between the physicians' vs. nurses' perceptions of challenges related to multimorbid care management and to the use of HIT were found.

Findings for Aim 2:

There were 204 patients sampled from the CC-MAP intervention patients who were included in the guideline recommendation assessment part of this study. Patient characteristics are presented in Table 3.

Table 3: Patient Characteristics

Patient Characteristics		N	%
Age (mean (SD))		72.31	(9.72)
Sex	Male	117	57.4%
	Female	87	42.6%
Time in CC-MAP (index)	New (≤ 6 months)	87	42.6%
	Veteran (≥ 11 months)	117	57.4%
Number of chronic conditions	1-4 conditions	99	48.5%
	5-6 conditions	82	40.2%
	7-10 conditions	23	11.3%
Number of patients with each focus condition (index)	Atrial fibrillation	50	24.5%
	Congestive heart failure	29	14.2%
	Chronic kidney disease	49	24.0%
	Chronic obstructive pulmonary disease	31	15.2%
	Depression	38	18.6%
	Diabetes	128	62.7%
	Dyslipidemia	178	87.3%
	Hypertension	181	88.7%
	Ischemic heart disease	90	44.1%

Overall, retrieving information on guideline concordance for each patient from the EHR took between 20-95 minutes (average: 35 minutes). The amount of time to retrieve data was dependent on the number of conditions, the number of consultations, the number of recommendations related to the specific conditions that the patient had, and the number of tests and medications. Care for CC-MAP patients was on average 88% (SD 9%) concordant with guidelines. Of the 4939 recommendations relevant for the study population, an average of 21.2 (SD 5.4) care processes were recommended according to guidelines for each patient. The average rates of guideline-concordant recommended care stratified by care type was 34% (SD: 44%) for patient counseling interventions (e.g., recommendations to attend a diabetes self-management workshop), 77% (36%) for referrals to specialists, 88% (17%) for prescribing medications, 91% (9%) for referrals for

diagnostic and lab tests, and 98% (11%) for provision of lifestyle counseling recommendations (e.g., smoking cessation).

The main reasons for deviation from recommending or referring patients to perform guideline recommendations were as follows: *Side effects*: "The patient used to get Procor and he had serious side effects of hypothyroidism so the doctor stopped giving him this medication and he is fine now with other meds"; *Interactions*: "She wasn't recommended because she has atrial fibrillation which puts her at higher risk for complications..."; *Complex conditions*: "it's difficult for him to get around because he has a lot of pain from his prosthetic leg; until the prosthetic can be fixed it's difficult to send him to specialists and tests"; *Outdated information*: "No need because he's not symptomatic, and the diagnosis is from a long time ago, in 1999".

The results of the logistic regression analyses are provided in Table 4. Adjusted analyses (including the variables that were statistically significantly associated with guideline concordance in the unadjusted analyses) showed that the older the age, the smaller the odds for guideline concordance. Additionally, patients who were veteran (i.e., 12 months or more) versus new (less than 6 months) to the CC-MAP, had a 2-fold greater odds (95% CI: 1.14-3.76) for having care recommended or referred according to the clinical guidelines.

Table 4: Unadjusted and adjusted logistic regressions – correlates of guideline concordance

	Unadjusted		Adjusted	
	OR	95% CI	OR	95% CI
Age (ref: <65)	--		--	
65-75	0.51	0.23-1.12*	0.42	0.18-0.95**
76+	0.51	0.24-1.11*	0.41	0.18-0.92**
Sex (ref: female)	--		-	-
Male	0.92	0.52-1.60	-	-
Time in CC-MAP: (ref: New (≤6 months))	--		--	
Veteran (≥12 months)	1.75	1.00-3.07*	2.07	1.14-3.76**
Chronic condition count (ref: 2-4)	--		--	
5-6 chronic conditions	0.85	0.47-1.54	-	-
7-10 chronic conditions	0.47	0.19-1.20	-	-

*Significant at $p < 0.1$; **Significant at $p < 0.05$

Findings for Aim 3:

Patients' assessment of the degree to which their care is coordinated was collected via patient-reported telephone questionnaires at two time points: at 6 month and 12 months after initiation of participation. Table 5 presents the baseline characteristics of participants. The sample includes 356 patients (42% men) with mean age of 71 years, and on average 5 chronic conditions.

Table 5: Baseline characteristics of patients participated in the survey

Characteristic	
Age, mean (SD)	70.9 (10.2)
Female, n (%)	209 (58.1)
Number of chronic conditions, mean (SD)	4.99 (2.36)
PACIC at 6 month, mean (SD)	3.17 (0.95)

Table 6 demonstrates patient's reports on the PACIC coordination subscale at 6 month and 12 months after initiation of participation. Paired sample t-test comparing at 6 month and 12 month coordination assessments showed significant increase in the overall coordination levels, and specifically in performance of after visit follow-up, encouraging attendance in community programs, and discussing visits with other care providers.

Table 6: Paired samples t-test to assess the differences between care coordination characteristics at 6 month ("baseline") and 12 months after initiation of participation in CC-MAP

Item/subscale	Baseline Mean (SD)	12 months Mean (SD)	t	p
Contacted after a visit to see how things were going	2.8 (1.6)	3.9 (1.4)	-10.47	<.001
Encouraged to attend programs in the community that could help me	2.3 (1.6)	3.2 (1.8)	-7.25	<.001
Referred to a dietitian, health educator, or counselor.	3.4 (1.6)	3.6 (1.7)	-1.49	.14
Told how my visits with other types of doctors, like an eye doctor or other specialist, helped my treatment	3.4 (1.6)	4.0 (1.5)	-5.37	<.001
Asked how my visits with other doctors were going	3.7 (1.5)	4.1 (1.4)	-3.69	<.001
PACIC Coordination subscale	3.1 (1.1)	3.7 (1.1)	-8.56	<.001

5. Discussion and Conclusions

Our study provides a unique perspective on use of HIT and integrated care for multimorbid patients, using a mixed qualitative and quantitative design combining insights from multiple sources – physicians, nurses and patients. Together, our findings draw a comprehensive picture of the HIT and care related needs for a growing segment of the population – patients with multiple complex needs in a large healthcare organization with extensive use of HIT.

Our findings show that providers encounter many challenges in utilizing HIT in care management of patients with multimorbidity. While one of the main advantages of the EHR is that it enables documentation storage and retrieval of large amounts of a wide-range of patient data (Car et al., 2008), information is generally not organized in a way that supports various care planning and clinical decision making processes. Several of our findings support this conclusion. First, the interviews which presented nurses' and physicians' difficulties in identifying all relevant information pertinent to patients' care. Providers reported on duplications, omissions and outdated information which significantly affected their ability to generate a comprehensive picture of the patient's past and current status in order to guide current decisions. These findings are supported by the providers' survey on which the highest score on the scale of EHR features that support multimorbidity care management was the provision of comprehensive information on all patient health conditions, yet the lowest score pertained to the degree to which the EHR enables integration of guidelines from all providers.

This need for coordination was also evident from assessment of the degree to which guideline recommendations were met. Overall, there was a high rate (88%), of guideline-concordant care. Yet, despite these patients' participation in an intensive care management program, not all guideline-based recommendations were met. This was particularly the case for counseling and procedure interventions and specialist visit care driven by clinicians not referring care. Follow-up tests and medications were referred and completed to a high degree of guideline concordance. Across the three guideline concordance measures, being in the CC-MAP program longer was associated with increased odds that patients received high overall guideline-concordant care. Age had significant but varied associations

with the odds of referral, with older patients referred less guideline-concordant care. Older patients were less likely to have care referred according to guidelines than the youngest group of patients, possibly attributed to greater complexity, polypharmacy and considerations of frailty in these older patients (Willis et al., 2017; Luijks, Lucassen, van Weel, et al., 2015).

Additionally, the main reasons for non-guidelines concordance were related to potential interactions between treatments and conditions, outdated information which affected the relevancy of the recommendations and the complexity of the patient's overall condition. Clinician-reported reasons why care is not referred can be due to lack of applicability of specific care recommendations for certain patients given their clinical and personal circumstances, or overburden of care-related activities for the patient (Sinnott, Mc Hugh, Browne, & Bradley, 2013; Wallace, Salisbury, Guthrie, et al., 2015). Finally, as evident from our patient survey, patients rated the coordination of their care as poor-fair, especially at the early stages of inclusion in the CC-MAP program, indicating that receipt of coordinated care is challenging in this population group.

6. Policy Implications and Recommendations:

The National Health Insurance Law calls for the provision of high quality of care for all patient groups. Our study examines the degree to which high quality of care can be delivered to patients with multimorbidity through the support of CDS systems. Due to the exponential growth in the number of patients with multimorbidity and the escalating costs and burden related to their care it is imperative to find the best HIT solutions that can effectively support care for this patient population groups. Care for patients with multimorbidity faces many challenges, including duplication, omissions, and contradicted treatment. While HIT holds promise for reducing these gaps in care, experience to date shows that current HIT systems do not necessarily provide adequate solutions for high quality multimorbid care and that tailored CDS systems should be incorporated in HIT systems. The findings from this study can serve to guide practice and policy recommendations on how to best utilize HIT tools, in day-to-day care tasks in efforts to improve care for the most complex patients in our healthcare system.

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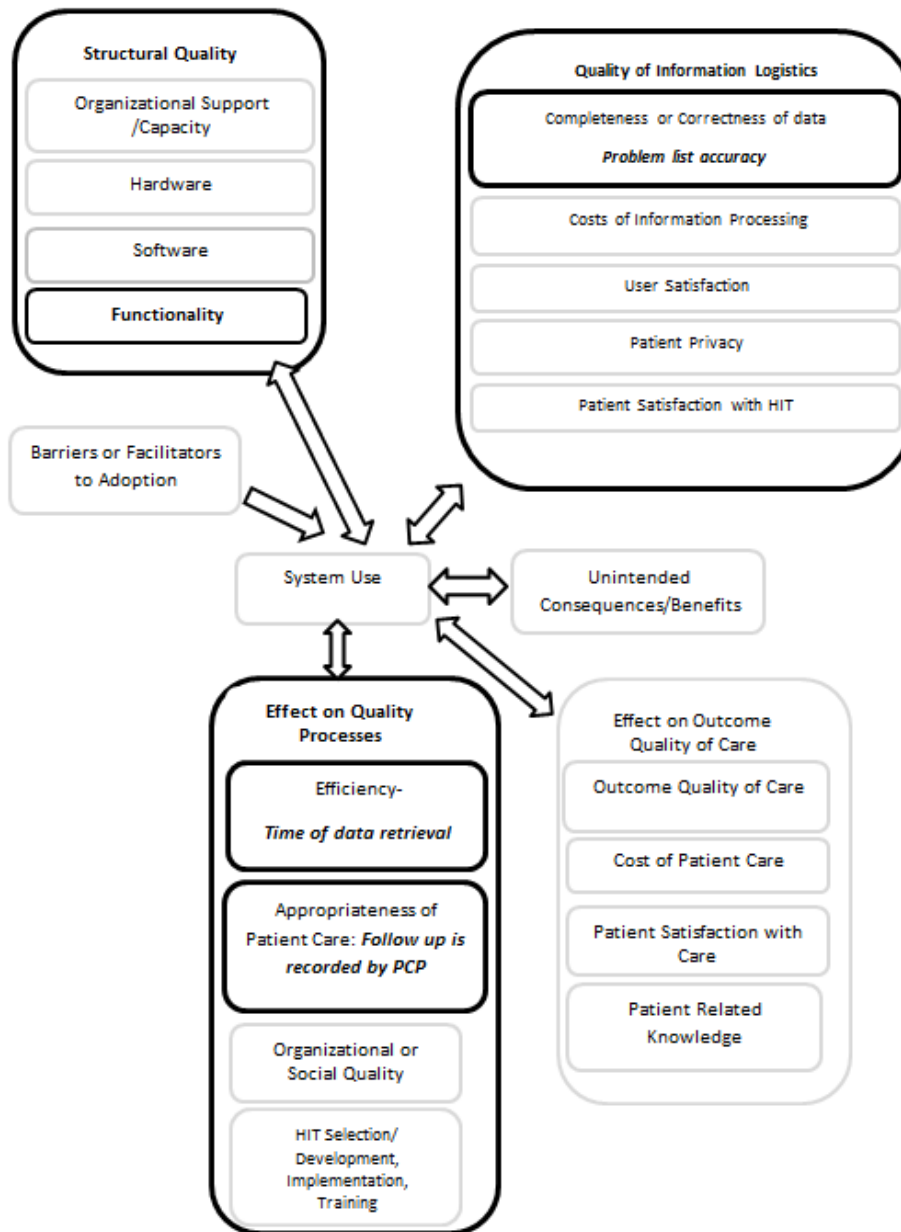
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Appendix 1: The HITREF Model



Model elements that appear in bold were included in the thematic classification

Appendix 2: Example of the abbreviated guidelines and data retrieval scheme for Chronic Obstructive Pulmonary Disease (COPD)

COPD	Is recommendation relevant for patient?	Indicate yes if patient was referred
Referral to smoking cessation workshop	☐	☐
Referral to pulmonary rehabilitation	☐	☐
Spirometry test ordered within the past year	☐	☐
Total		
Percent made of relevant recommendations		