An Ethical Theory of Progressive Independence:

Scoring VA's Resident Supervision Index

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INTRODUCTION

Graduate medical education (GME) is based on an apprenticeship, on-the-job training model.[1, 2, 3, 4] In clinical teaching settings, residents are given opportunities to provide patient care under supervision of an attending physician who, in turn, ensures those patients that their care will be safe and effective.[5, 6, 7, 8, 9] If the goal of resident training is self-regulating, independent practice, then residents should expect to be assigned to more patient care responsibilities and to more complex cases as their skills progress over the length of their GME training. However, few studies have tested this "progressive independence hypothesis"[10, 11, 12] in actual teaching settings.

Indeed, mounting such a test would entail both theoretical and empirical limitations. A model of GME is necessary to explain how supervision decisions are made and to provide the proper context for such a test. Empirically, a measure of supervision intensity is needed to quantify how much a resident is given responsibility for the care of a patient.

In this paper, we (*i*) quantify the intensity of resident supervision by scoring responses to the Resident Supervision Index – Inventory (RSI-Inventory) and (*ii*) develop an ethical theory of resident supervision in order to (*iii*) test for progressive independence with data from resident outpatient rotations at a Department of Veterans Affairs medical center.

RESIDENT SUPERVISION INDEX - *RSI*

Definitions

To quantify supervision, we describe how responses to the Resident Supervision Index-Inventory can be scored to quantify care responsibility. With psychometric properties detailed elsewhere,[13] the RSI is a content-valid, reliable, structured inventory administered to both

attending physicians and residents. The interview is designed to collect information that describes resident-attending interactions regarding the care of a given patient seen in non-procedural, outpatient settings. The RSI measures intensity in terms of physician time to reflect physician workload.

Extending the original framework of Kennedy et al.,[21] physician time comprising a *supervision encounter* between a resident, faculty, and patient is divided into separate components (Table 1). (1) *Oversight*: To oversee residents, the attending physician purposefully gathers information about the patient's clinical progress and the resident's performance by reviewing charts, evaluating patients directly, or discussing the case with other professional staff. (2) *Discussion*: Attending physician and resident may also discuss a given case covering the patient's history, examination findings, interpretation of diagnostic tests, diagnosis, assessments, and care plans. Discussions can include (1a) any contact between resident and faculty involving the specific case (*all discussion*), or (1b) be limited to discussions that enhanced the resident's understanding of the case (*case understanding*), and (1c) be limited further to discussions that led to changes in the patient's care (*care change*). (3) *Patient care*: Patient care includes time when the attending physician or resident participated in the patient's care. As faculty participates in care, the resident is either (3a) not present, (3b) is observing care, or (3c) cares for the patient by assisting the attending physician. If the attending physician is not participating, the resident is said to be involved in caring for the patient as the attending physician is either (3d) observing the resident provide care, or (3e) is not physically present in the examining room. In the latter case, the resident is said to be *independently involved* in caring for the patient.

Scoring Strategy

Table 1 describes how responses to the RSI-Inventory are scored into eight component and three summary rates. Each component represents different parts of the supervision encounter. Components are scored so that higher scores reflect more care responsibility, or alternatively less supervision. A score of zero indicates maximum supervision and minimum care responsibility. A score of one indicates minimum supervision and maximum care responsibility. The summary score reflecting all components together is calculated by multiplying the separate component scores together.

The RSI is a complex index integrating four patient care rates (R_{p1}, R_{p2}, R_{p3}, R_{p4}), three discussion rates (R_{d0}, R_{d1}, R_{d2}), and an oversight rate (R_o) (Table 1). Among patient care, the i*nvolvement rate* (R_{p1}) is the proportion of time a resident is involved in patient care when the attending physician is not present. A value of one means the attending physician was not present while the resident was involved in patient care. A value of zero means the attending physician was always present while the resident was involved in the patient's care, or alternatively the resident was not involved in the patient's care. The *assistance rate* (R_{p2}) is the proportion of a resident's patient care time when the resident was involved in caring for the patient and free from merely assisting faculty. A value of one means the resident was fully involved in the patient's care and did not assist faculty. A value of zero means the resident only assisted faculty when caring for the patient or the resident never cared for the patient. The *observation rate* (R_{p3}) is the proportion of time the resident spends with the patient when the resident was caring for the patient and free from merely observing care. A value of one means all of the time the resident spends with the patient was spent caring for the patient. A value of zero means the resident only observed

care and was never involved or assisted in care, or the resident spent no time with the patient. The *absence rate* (R_{p4}) is the proportion of the total patient care time when the resident was present with the patient. A value of one means the resident was never absent when the patient was receiving care. A value of zero means the resident was never present while the patient received care. The discussion *contact rate* (R_{d0}) is the proportion of faculty interaction time when the resident and attending physician discussed the case. Faculty interaction time is the sum of patient care and discussion times. A contact rate of one means no discussion was held. A contact rate of zero means the supervision encounter was entirely based in discussions and did not involve patient care. Contrary to the other components, the two discussion rates (R_{d1} and R_{d2}) are designed to adjust the discussion contact rate to exclude discussion time that did not enhance case understanding (R_{d1}) or change the patient care plan (R_{d2}), and are thus equal to or greater than one. Thus, the product $R_d R_{d1} R_{d2}$ computes a new contact rate in which only discussion that enhanced case understanding and changed care is counted. Finally, the *oversight rate* (R_o) is the proportion of the total supervision encounter comprising patient care or discussion. As mentioned earlier, the supervision encounter time includes patient care, discussion, and oversight activities. An oversight rate of one means there was no oversight activity for the given supervision encounter. An oversight rate of zero means the supervision encounter was made up entirely of oversight activities and the resident did not discuss the case or was involved, assisted, or observed the patient's care.

The Resident Supervision Index (*RSI*) summarizes all eight component scores and is computed by RSI = $[R_{p1}\ R_{p2}\ R_{p3}\ R_{p4}]$ x $[R_{d0}\ R_{d1}\ R_{d2}]$ x R_o. RSI equals the proportion of the supervision encounter time when the resident was independently involved in the patient's care.

The RSI declines from one whenever more time is devoted to any supervision element other than independent involvement in patient care. The multiplicative property of the component rates permits the computation of "subscores." We define two such scores. RSI-interaction (RSI_I) is a summary score that drops the oversight component (R_o) in order to focus on resident-faculty interactions. $RSI_I = [R_{p1}\ R_{p2}\ R_{p3}\ R_{p4}] \times [R_{d0}\ R_{d1}\ R_{d2}]$. RSI-discussion ($RSI_D$) drops both oversight ($R_o$) and discussion qualifications (R_{d1}, R_{d2}) in order to emphasize the total time spent between resident and faculty. $RSI_D = [R_{p1}\ R_{p2}\ R_{p3}\ R_{p4}] \times [R_{d0}]$.

ETHICAL SUPERVISION

Overview

Described in Figure 1, GME includes didactic education as well as opportunities to engage in supervised research and clinical care. This paper focuses on clinical care learning opportunities when residents rotate through outpatient teaching clinics. We begin with a resident reporting to a supervising attending physician in clinic who,, in turn, assigns the resident to patient cases. Such assignments are based by the attending physician deliberately matching patients to the skill level of their residents (Figure 2a), or by chance (Figure 2b). Once cases are assigned, the Ethical Supervision Model is designed to explain how attending physicians supervise residents during a supervision encounter. This supervisory events are defined in terms of the attending physician, the resident trainee, the assigned patient, and the index outpatient visit. Borrowed from economic theory, we assume that for each encounter the attending physicians supervises residents to maximize the safety and effectiveness of care for patients first, followed by maximizing clinical opportunities for trainees to further their professional development. Such supervision, however, does not occur in a vacuum. The attending physician must produce workload to care for

presenting patients within the limits of available professional staff as well as other resources. These resource constraints and demands for patient care workload will inevitably have an impact on both patient outcomes and resident clinical opportunities. We thus build an "ethical" model by assuming that the supervising physician's first priority is to maximize the patient's health outcome first. That is, residents are allowed clinical responsibilities that will further their professional development only when it "does no harm" to the patient. Under this theory, patient outcomes would depend only on resource availability, faculty skills, clinic culture, etc., and would be no worse than if the patient had been treated without resident trainees present. Our purpose is to determine if, under such "ethical" constraints, what conditions are necessary for progressive independence to be possible.

Model Assumptions

Model assumptions are as follows. (#1) *Optimum Outcome*. Clinic faculty will allocate available professional staff and residents to optimize the outcomes of all patients who present at the clinic during the day of the index visit. Expected outcomes will depend on the clinical complexity of assigned cases, total workload demands placed on available professional staff at the clinic, and other faculty and clinic characteristics. (#2) *Optimal supervision*. Faculty will offer residents the most clinical opportunities, the least supervision, and the most care responsibility that would allow patients to achieve their respective maximum expected outcome as resident training does-no-harm. (#3) *Declining outcomes*. Residents can provide workload and effectively expand the availability of professional resources. However, their impact on patient outcomes will decrease with diminishing supervision intensity, but at rates that depends on the complexity of the patient's case and the level of the resident's clinical competencies. (#4) *Progressive learning*:

Residents gain clinical competencies during their GME training. (#5) *Knowledge*. Faculty has direct knowledge about the patient case and the resident's clinical competencies. (#6) *Revealed knowledge*. Faculty reveals this knowledge when supervising residents in patient care.

Hypotheses Derived

To describe how supervision is determined for a given supervision encounter, we divide the model in clinics where patients are assigned based on resident experience (Figure 2a) or at random (Figure 2b). Supervision intensty, described in terms of the amount of care responsibility assigned to the resident, is determined from the complexity (c) of the assigned patient case, the resident's length of GME training (t), the clinic's workload (w), the patient's health outcome (q), and other factors (H^0). The vector of other factors (H^0) includes characteristics of the patient, resident, attending physician, and the teaching clinic, as well as the clinic's professional staff and other residents during the given resident's rotation. We hold these other factors constant in order to focus on the hypothetical associations between resident lengths of training, patient outcomes, case complexities, workload, and supervision levels.

Illustrating the model using Figure 2a, let the length of the resident's GME training (in months) be represented by moving right along the x-axis from a novice-level (t_1) to an upper-level (t_2). Under assumption #4, more months in training reflect greater clinical competencies. Residents who are given more clinical responsibility is represented by moving up along the y-axis to reflect more care responsibility for an assigned case, and down along the y-axis to reflect more difficult cases, or more case responsibility. Care responsibility increases from r_0 to r_1 and to r_2 as the resident receives less direct supervision from the attending physician for a given assigned patient. Case responsibility increases from c_1 to c_2 as the resident cares for patients with

increasing case complexity that requires more clinical skills to achieve an acceptable patient outcome. Moving left along the x-axis represents better patient outcomes that increase from q_2 to q_1 as patients receive more appropriate care (process) from providers with greater skills.

We use Figure 2a to describe the curves depicted in each of the four quadrants. Under assumption #3, the supervision-outcome curves that are depicted in the upper left quadrant describe the relationship between patient outcomes (q) and care responsibilities (r). These curves show patient outcomes declining when residents are given more care responsibilities. This decline is shown to drop sharply at a point when the resident is provided too little supervision for a given case and becomes "clinically overwhelmed." How quickly outcomes fall depends on case complexity (c), the resident's level of training (t), and other characteristics of the supervision encounter (H^0).

By assumption #1, complexity-expected outcome curves, depicted in the lower left hand quadrant, describe the optimal patient outcome - q^e. These values are determined collectively by clinic faculty and represent decisions to allocate the clinic's scarce professional resources (staff and residents) to optimize patient outcomes and achieve an expected patient outcome. This expected optimal outcome will decrease from q_1^e to q_2^e as case complexity increases from c_1 to c_2 whenever clinic's workload remains the same (w_1) for a given supervision encounter (H^0). Illustrated in Figure 2b, these case complexity-expected outcome curves "shift" to the right as workload increases ceterus paribus from w_1 to w_2, placing greater patient care demands on existing staff, and leading expected optimal outcomes to decline from q_1^e to q_2^e.

From assumption #2, faculty will allow the resident more care responsibility up to r_1 when the patient's outcome (q_1) under the resident with resident training level (t_1), equals the expected

optimal outcome (q_1^e) determined from case complexity (c_1), clinic workload (w_1), and supervision encounter (H^0). That is, the attending physician minimizes supervision, and thus maximizes the resident's clinical opportunities, educational experiences, and care responsibilities, up to the point when patient actual outcome equals the faculty-determined expected outcome: $q_1=q_1^e$ and $q_2=q_2^e$.

Case complexity-training curves, depicted in the lower right quadrant in Figure 2a, shows residents with more GME training (t_1 to t_2) will be assigned to patients with more complex cases (c_1 to c_2), representing more progressive case responsibility. By contrast, Figure 2b depicts residents who are assigned to cases "at random." Here, complexity-training curves are shown as flat lines over the resident's GME experience.

Progressive responsibility curves are depicted in the upper right quadrant. Constructed from relationships contained in the other three quadrants, these curves describe the association between training level and care responsibility for the given supervision encounter. Specifically, for a given case complexity (c_1), clinical workload (w_1), and supervision encounter (H^0), the model predicts that residents whose training advances from t_1 to t_2 will be assigned to more care responsibility from r_1 to r_2, represented by the curve $r(t|c_1,w_1,H^0)$. This curve is called a "short-run" progressive care responsibility curve because it depicts care responsibility when the same case complexity is assigned to the resident at different stages of their GME training. Figure 2a, however, describes progressive *case* responsibility as residents are offered more challenging cases as they progress through their GME training (Figure 2a). Thus, we depict the "long-run" progressive responsibility curve, $R(t|w_1,H^0)$, describing how care responsibility changes during the length of GME training when case complexity is also allowed to increase during the length of the

resident's GME training. Our theory helps us to define the progressive independence hypothesis as either an increasing short-run progressive care responsibility under progressive case responsibility ($r(t|c_1,w_1,H^0)$ in Figure 2a), or a long-run progressive care responsibility when patient cases are assigned at random ($r(t|c_1,w_1,H^0)$ in Figure 2b). Therefore, the *progressive independence hypothesis* can be described as a positive association between length of GME training and resident responsibility whenever case complexity is held constant.

While not the focus on this paper, there are other confirmatory hypotheses which can be shown from the model. Ceterus paribus, the *workload effect hypothesis* states that care responsibility increases with increasing clinicl workload, and the *complexity effect hypothesis* states that care responsibiltiy decreases with increasing case complexity.

METHODS

Data

Data come from the Department of Veterans Affairs (VA) Resident Supervision Index (RSI) Feasibility Trial[13] assessing the content-validity, test-retest, and concurrent reliability of the RSI-Inventory *ver*. 3.11. Using a structured interview, trained researchers administered the RSI-Inventory during face-to-face contacts to physician residents rotating through the outpatient primary care general internal medicine clinics at the VA Medical Center in Loma Linda, CA. Under a VA IRB-approved protocol, RSI-Inventories were administered at the end of the resident's shift to describe all supervision encounters that had occurred between the resident and their attending physician regarding a study patient. Study patients were selected at random from among outpatient appointments scheduled for the summer 2008 for patients with diagnoses of

diabetes and/or major depression. These diagnoses were selected to reflect high prevalence among VA patients and moderate case complexity.

Supervision was measured by scoring resident responses to the RSI *ver*. 3.11 administered at the end of the resident's shift. Included were discussion and patient care component scores, and the RSI-interaction summary scores that focused on faculty and residents interactions but excluded faculty oversight. Our purpose was to test the progressive independence hypothesis by highlighting on resident-faculty interactions. Oversight components of supervision describe how attending physicians gather facts about resident performance and case complexity that guide those interactions with residents, alleged in the knowledge assumption (#5).

Patient care demographics, diagnoses by ICD-9 codes, and VA use of inpatient and outpatient care information were obtained from VA's electronic databases.[14, 15] All 3, 4, and 5-digit ICD-9 codes were aggregated into the seventeen ICD-9 disease classes (see Table 3). Demographic, education and graduate medical education information about participating residents and their attending physicians were obtained from questionnaires administered during face-to-face interviews following signed informed consent. The length of the resident's current GME training program was measured in months. Prior residency program experience was considered as a covariate describing the resident. Case complexity for the patient encounter was measured by: (1) the number of different clinical conditions treated; (B) the Reasonable Charge for the most expensive procedure performed; and (C) the presence or absence of ICD-9 conditions diagnosed and appearing in the electronic medical record within 90-days prior to and/or 30-days subsequent to the index clinic visit, as well as an inpatient discharge occuring within 90-days prior to the index clinic visit. Outpatient care was measured as simple counts of visits, clinic stops,

procedures done based on CPT codes, and Reasonable Charges. Inpatient care was measured by the number of admissions, bedsection transfers, days stayed, and Reasonable Charges. Reasonable Charges[16, 17, 18] are computed officially by the Department of Veterans Affairs representing the 80th percentile (2008$) of national paid transaction charges for U.S. health care. The strategy is based on the assumption that higher cost procedures require more clinical skills to perform. Workload is measured by assessing for a fixed number of residents and attending physicians the number of unique patients seen, number of procedures performed, and number of procedures peformed weighted by their respective Reasonable Charge, in the clinic during the day when the supervision encounter occurred.

Analyses

Linear regression models were used to assess the association between length of GME training and RSI supervision rates after adjusting for covariates selected from classes of variables representing characteristics of residents, attending physicians, patients, case complexity, and clinic workload. An exhaustive search procedure was used within each covariate class to identify potential confounds for the model.[19] With complex four-way interactions between resident, attending physician, unique patients, and clinic shift, we assumed supervision for the 140 encounters were independently distributed for our limited analyses. Progressive case responsibility is not likely to confound results since clinic patients were assigned to residents “at random.”

RESULTS

A total 57 residents (Table 2) and 37 attending physicians (Table 2) cared for 136 patients (Table 3) during 140 supervision encounters from June 9 through September 5, 2008. These

tables reveal a wide mix of patients, residents, and attending physician characteristics. Mean daily workload when residents were present covered 137 shifts that averaged 578 patients (s.d.=36, 80%[525, 606]) and 2,309 procedures per day (s.d.=189, 80%[2,109, 2,546]) at a market value of $146,202/day (s.d.=1,130, 80%[$130,876, $161,967]).

Descriptive values for RSI-interaction and component scores are provided in Table 4. The mean RSI-interaction score is 0.86. That is, the resident's independent involvement in patient care made up 86% of the supervision interaction encounter. Exactly half (70) of supervision encounters contained resident-attending interactions (R_I <1), where the resident's independent involvement made up 71% of the time of the patient care and discussion components, or interaction encounter. The most prominent components were the assistance and discussion rates. In 35 of 140 cases (25%), residents assisted faculty to make up 24% ($1–R_{p2}$ =1–76%) of resident provided care. Discussions occurred in 135 of 140 encounters (96%) accounting for 22% of the interaction encounter time {$1 – R_{d0} = 1 – 0.78 = 0.22$}. Only 43 of 140 encounters (31%) contained discussion that both enhanced understanding and changed care, amounting to only 5% of interaction encounter time {$1 – (R_{d0}R_{d1}R_{d2}) = 1 – (0.78*1.03*1.18)$}.

Table 5 provides test results of (short-run) associations between length of GME training and care responsibility, after adjusting for case complexity, clinic workload, as well as patient, resident, and attending physician characteristics. GME training was associated with an increase RSI-interaction scores of 4.4%, computed per year of training, indicating a positive impact on care responsibility and consistent with the progressive independence hypothesis. The increase in care responsibility was primarily the result of fewer care-changing discussions and resident patient care time that was freed from having to assist faculty provide care. Upper level residents also spent 2.7

minutes (10%) less time independently involved in care per additional year of training. This is also consistent with both progressive independence hypothesis and assumption #6; that is, residents may learn during their GME experience to become more efficient at producing care.

We also provided tests for case complexity and workload effects as confirmatory analyses of the underlying ethical theory of supervision. Regarding case complexity, residents treating patients with hypertension and circulatory disorders tended to get more case-understanding discussion, were more often asked to assist rather than be involved in care, and provided less independently involved care than their counterparts who treated, on average, patients with other disorders. Consistent with the progressive independence hypothesis, the impact on care responsibility for residents treating patients with both disorders was greater for residents during their first year (β=-0.385, s.d.=0.11, t=3.38, p=.001) than for residents during their third year (β= –0.089, not significant), for a difference (Δ=0.296 (s.e.=0.135, t=2.19, p=.030).

Gastrointestinal (GI) conditions were associated with less, rather than more, supervision. That is, patients presenting with GI conditions tended to receive more independently involved care from residents freed from having to assist faculty in providing care. The number of conditions treated, however, did not impact the supervision interaction rate (RSI-interaction). However, when patients present with a greater number of conditions, faculty were more likely to free residents from assisting in care, but only to spend more time observing the resident while the resident was involved in patient care. The net effect was no change in the RSI-interaction score. Similarly, supervisors tended to respond to patients who required more complex procedures (higher CPT charges) by reducing contact discussion, only to require residents to assist faculty perform procedures that otherwise the resident would perform when faculty either observed or was

not present. Also consistent with the ethical theory, supervisors facing higher workload rates tended to offer residents more care responsibility by freeing residents from having to assist attending physicians. The findings reflect how faculty responded when faced with pressures from workload and patient care demands. Attending physicians holding advanced graduate degrees were more likely to free residents from contact discussions while residents spent more time independently involved in patient care. This may be the result of these attending physicians being involved in research activities or administrative duties that competed for their time when supervising residents. Finally, residents treating patients with private health insurance tended to be given less supervision by freeing residents from discussion contacts. One may speculate that patients with private coverage are in overall better health that require less complex care than their non-covered counterparts.[15, 20]

DISCUSSION

In this paper, we tested for the progressive independence hypothesis by scoring the Resident Supervision Index (RSI) to quantify resident supervision, by developing an "ethical" theory of resident supervision to explain under what conditions in teaching outpatient care clinics can one expect to observe progressive independence, and by applying both measure and theory to data on residents rotating through outpatient clinics at a VA medical center during the summer of 2008. Our preliminary results suggest that, at least for one VA medical center, progressive independence was observable. Such evidencing of progressive independence becomes an indirect test of progressive learning. That is, showing that residents assume more progressive care responsibilities is an indirect test that residents are progressive learning, provided the optimality

and knowledge assumptions described in the theoretical framework are true. For that reason, we should consider this evidence of progressive independence as preliminary.

To our knowledge, a similar study of progressive independence has not been done. Supervision in prior studies has often been described as oversight designed to ensure the quality of care.[21, 22] Estimates have been based on whether the attending physician made a chart notation,[23] was physically present[24] or involved,[25, 26] identified discrepancies,[27] or participated on the health team.[6] Our combined empirical and theoretical approach builds on the Institute of Medicine's report[1] that expanded this oversight role to view resident supervision as "optimized" behaviors focusing on patient care and education goals as: "…matters of personal, professional, and educational development in the context of a trainee's experience of providing safe and appropriate patient care."

Under the theory developed here, supervisors are assumed to maximize patient outcomes first. The superviser then assign to residents the maximum level of responsibility to care for the patient that can sustain the optimum patient outcome. We thus call this an "ethical" theory because patient outcomes come first, while residents are engaged in clinical care under a "due no harm" prinicple. Our theory has two important implications. First, we distinguish progressive independence of a resident's responsibility for care (progressive care responsibility) from progressive assignment to more clinically challenging and complex cases (progressive case responsibility). The distinction is important because the progressive independence hypothesis (*care* responsibility) may be true even though supervision rates may actually increase with length of GME training, as shown in Figure 2a. Our empirical analyses revealed supervision was associated with the patient's diagnoses, number of treated conditions, and the complexity of

clinical procedures performed during the patient's visit. These findings underscore the importance of adjusting for case complexity (*case* responsibility) when testing for progressive independence. A second theoretical implication is that a test for progressive independence will depend on controlling for variation in clinic workload, but not necessarily patient outcomes. This is important because patient outcomes are difficult to measure and present statistical challenges in analyses. Specifically, our theory treats optimum patient outcomes as a resource allocation problem driven by workload demands on the limited supply of the teaching clinic's professional staff and residents. This is important because it suggests that supervision and patient outcomes across teaching clinics may be related even though each clinic optimizes patient oucomes. This can be seen from our Figure 2b, where a ceterus paribus increase in clinic workload from w_1 to w_2 is theoretically expected to shift the progressive care independence curve upwards from $r(t|c_1,w_1,H^0)$ to $r(t|c_1,w_2,H^0)$, as optimum supervision increased from r_1 to r_1'. The same change in workload from w_1 to w_2 is also expected to shift the case complexity-expected outcome curve to the right, as optimum patient outcomes decreased from q_1 to q_2. The combine effect leaves optimum care responsibility inversely related to optimum patient outcomes, even when teaching clinics offer "do-no-harm" training to residents. Thus, the empirically observed associations between supervision and patient care outcomes[6, 23, 24, 25, 26, 27] can be explained by our ethical theory as a consequence of faculty allocating scarce professional resources in the face of increasing workload demands from clinic patients. Our data confirms this interpretation as we found workload effects on decreasing supervision rates (increasing responsibility of care), a finding consistent with the reported literature.[28, 29] Associations between resident supervision and patient outcomes may thus be a manifestation of scarce resources rather tradeoffs between resident

education and patient care needs. More research, however, is recommended to understand how supervision relates to both patient health and trainee education outcomes.

Our analyses showing the impact of resident, faculty, patient, and clinic workload characteristics on measured supervision rates lend support to our theory of supervision and offers construct validity for our scoring strategy that quantifies supervision from responses to the Resident Supervision Index – Inventory. The summary and component scores that quantifies supervision intensity in terms of professional time are consistent with the GME literature. Attending physicians have been observed to spend more time overseeing the care of less experienced residents,[30, 31, 32] leading to changes or validation of resident-provided treatment plans,[33] patient history, diagnostic testing, diagnosis, follow-up care, and medication management,[34, 35] greater compliance with process-of-care guidelines in emergency departments,[23] more correct readings of computed tomography scans,[27] lower death and complications rates from surgery,[22, 24] lower medical errors rates, and fewer malpractice claims.[6]

Our analyses also revealed that case complexity, workload, and patient-level predictors had different impacts on components, including assistance, involvement, and discussion rates. Such a finding underscores the importance of quantifying separately the mix of different components of supervision to better understand the content of a supervision encounter.

The present study is subject to the following limitations. The data are derived from only one site. The use of non-VA sources of care was not considered. The study did not measure the appropriateness of supervision, the quality of care, or patient outcomes. Moreover, only theoretical implications were empirically examined, rather than directly and separately testing each working hypothesis separately.

This paper lays the foundation for an ethical theory of supervision that considers both education and patient care goals, but places patient care first. Within this theoretical framework, we derived a scoring strategy to measure resident supervision quantitatively. While we provide some evidence for the progressive independence hypothesis, more studies are needed to further refine and test this analytic framework and better understand how residents are supervised in the teaching clinical care settings.

Figure and Tables

Table 1: Description of Scoring Methods for Resident Supervision Index

Time Element	Faculty	Resident	Sym[1]	Location[2]
Patient Care				
indep'ly involved	not present	involved	t_{p0}	[2(B)(b)(*iii-v*)], *ver*. 3.11
involved	present	involved	t_{p1}	[2(B)(b)(*ii*)], *ver*. 3.11
assisted	participated	assisted	t_{p2}	[2(B)(b)(*i*)], *ver*. 3.11
observed	participated	observed	t_{p3}	[2(B)(a)], *ver*. 3.11
absent	participated	not present	t_{p4}	[2(C)], *ver*. 3.11
Discussion				
contacted	present	present	t_d	[2(A)], *ver*. 3.11
enhanced case understanding	present	present	u_1	[3(A)], *ver*. 3.11
changed care plan	present	present	u_2	[3(B)*i-vi*], *ver*. 3.11
Oversight				
reviewed chart	present	not present	t_o	[1(A)(i)] + [1(A)(iii)] + [1(B)] + [1(C)], *ver*. 4.01.
evaluated patient	present	not present		
consulted with staff	present	not present		

Computation	Formula[3]
Supervision Encounter Time	$T = t_{po} + t_{p1} + t_{p2} + t_{p3} + t_{p4} + u_1 u_2 t_d + t_o$
Summaries	
RSI:	$RSI = (R_{p1})(R_{p2})(R_{p3})(R_{p4})(R_{d0}R_{d1}R_{d2})(R_o) = t_{p0}/T$
RSI-interaction:	$RSI_I = (R_{p1})(R_{p2})(R_{p3})(R_{p4})(R_{d0}R_{d1}R_{d2}) = R/R_0$
RSI-discussion:	$RSI_D = (R_{p1})(R_{p2})(R_{p3})(R_{p4})(R_{d0}) = R/(R_0)(R_{d1})(R_{d2})$
Patient Care Components[4]	
involvement:	$R_{p1} = \left(\frac{t_{p0}}{t_{p0} + t_{p1}} \right)$
assistance:	$R_{p2} = \left(\frac{t_{p0} + t_{p1}}{t_{p0} + t_{p1} + t_{p2}} \right)$
observation:	$R_{p3} = \left(\frac{t_{p0} + t_{p1} + t_{p2}}{t_{p0} + t_{p1} + t_{p2} + t_{p3}} \right)$
absence:	$R_{p4} = \left(\frac{t_{p0} + t_{p1} + t_{p2} + t_{p3}}{t_{p0} + t_{p1} + t_{p2} + t_{p3} + t_{p4}} \right)$

Table 1: Description of Scoring Methods for Resident Supervision Index

Discussion Components[5]

contact:

$$R_{d0}=\left(\frac{t_{p0}+t_{p1}+t_{p2}+t_{p3}+t_{p4}}{t_{p0}+t_{p1}+t_{p2}+t_{p3}+t_{p4}+t_{d}}\right)$$

case-understanding:

$$R_{d1}=\left(\frac{t_{p0}+t_{p1}+t_{p2}+t_{p3}+t_{p4}+t_{d}}{t_{p0}+t_{p1}+t_{p2}+t_{p3}+t_{p4}+u_{1}t_{d}}\right)$$

care-change:

$$R_{d2}=\left(\frac{t_{p0}+t_{p1}+t_{p2}+t_{p3}+t_{p4}+u_{1}t_{d}}{t_{p0}+t_{p1}+t_{p2}+t_{p3}+t_{p4}+u_{1}u_{2}t_{d}}\right)$$

Oversight Component[6]

oversight:

$$R_{o}=\left(\frac{t_{p0}+t_{p1}+t_{p2}+t_{p3}+t_{p4}+u_{1}u_{2}t_{d}}{t_{p0}+t_{p1}+t_{p2}+t_{p3}+t_{p4}+u_{1}u_{2}t_{d}+t_{o}}\right)$$

1 – Symbol t indicates time in minutes; u_1 =1 if a discussion contact enhanced resident's case understanding and =0 otherwise; u_2 =1 if a discussion contact changed care plan and =0 otherwise.

2 – Location on the survey, version 3.11 or 4.01, with question number indicated in brackets.

3 – Whenever the denominator equals zero, the ratio is defined to equal zero.

4 – *Involvement rate* component equals the proportion of time that the resident was involved in patient care when the attending was not physically present in the room. *Assistance rate* component equals the proportion of time that the resident was caring for the patient when the resident was not assisting faculty participation in care. *Observation rate* component equals the proportion of time that the resident was present with the patient when the resident not merely observing care. *Absence* component equals the proportion of time during the patient's care when the resident was present.

5 – Discussion *contact rate* component equals the proportion of total interaction (patient care plus discussion) for discussion time. *Case-understanding* component is a correction factor that when multiplied to the contact rate increases the score towards one (indicating more responsibility and less supervision) by arithmetically excluding discussion that did not enhance the resident's understanding of the case. *Care-change* component is a correction factor that when multiplied by the contact and case-understanding rates increases the score towards one by arithmetically excluding discussion that did not lead to a change in the patient's care.

6 – *Oversight* component equals the proportion of the total supervision encounter time when the attending physician was gathering information to evaluate the resident's performance for the given patient case.

Table 2: Demographic, Specialty, and Medical Education Characteristics of Responding Residents and Attending Physicians

	Resident Physicians		Attending Physicians	
Number	57		37	
Age[1]	32 *yrs*	(5), [25 − 46]	43 *yrs*	(9), [30 − 61]
total reporting	55		37	
<25	0	0%	0	0%
25-34	41	74%	10	27%
35-44	11	20%	10	27%
45-54	3	5%	12	32%
55-64	0	0%	5	14%
65+	0	0%	0	0%
Gender (female)				
total reporting	56		37	
female	24	43%	12	32%
male	32	57%	25	68%
Race/ethnicity				
total reporting	52		35	
African American	3	6%	5	14%
Asian	23	44%	20	57%
Latino	1	2%	1	3%
Middle Eastern	5	7%	0	0%
Native American	5	10%	1	3%
White	22	29%	8	23%
Years college graduation	9 *yrs*	(5), [4 – 26]	21 *yrs*	(9), [8 − 40]
Years medical graduation	5 *yrs*	(6), [0 – 22]	17 *yrs*	(9), [4 – 39]
total reporting	46		37	
01 – 04 years	22	48%	3	8%
05 – 09 years	14	30%	9	24%
10 – 14 years	4	9%	4	11%
15 – 19 years	4	9%	7	19%
20 – 24 years	2	4%	8	22%
25 – 29 years	0	0%	2	5%
30+ years	0	0%	4	11%
Medical School Location				
total reporting	56		37	
US	30	54%	28	76%
non-US	26	46%	9	24%
US Residency – level				
total reporting	56		36	
PGY – 1	22	39%	0	%
PGY – 2	16	28%	0	%
PGY – 3	15	27%	19	53%

Table 2: Demographic, Specialty, and Medical Education Characteristics of Responding Residents and Attending Physicians

	Resident Physicians		Attending Physicians	
PGY – 4	1	2%	10	28%
PGY – 5	0	0%	2	5%
PGY – 6	1	2%	5	14%
PGY – 7	1	2%	0	0%
US Residency – specialty				
total reporting	56		37	
Internal medicine	47	84%	33	89%
Preventive Medicine	2	4%	0	0%
Surgery	4	7%	4	11%
Psychiatry	2	3%	0	0%
Podiatry	1	2%	0	0%
Entered non-US Residency				
total reporting	57		37	
yes	6	11%	4	11%
none	51	89%	33	89%
Advanced Degree				
total reporting	57		37	
Master/Doctorate	12	21%	6	16%
none	45	79%	31	84%

1 – Standard deviation in parentheses, minimum and maximum values in square brackets.

Table 3: Demographic, Use of Inpatient and Outpatient Care, and Diagnoses of Study Patients

Category	Value/Num	Percent, (sd) [range]
Number	136	
Age[1]	63 *yrs*	(11), [24 – 91]
total reporting	136	
<25	1	1%
25-34	1	1%
35-44	2	1%
45-54	23	17%
55-64	55	40%
65+	54	40%
Gender (female)		
total reporting	136	
female	7	95%
male	129	5%
Annual Income		
total reporting	128	
00 – 24k	75	59%
25 – 49k	48	37%
50 – 74k	1	1%
75 – 99k	3	2%
100k+	1	1%
Priority Status Veteran[1]		
total reporting	136	
Priority	119	87%
Other	17	13%
Health Insurance Coverage		
total reporting	136	
Private health insurance	60	44%
None	76	56%
Outpatient Care		
total reporting	136	
Day of Encounter		
Reasonable Charges		
total	$583	(634), [164 – 3,892]
maximum procedure	$365	(450), [61 – 3,643]
Mean number procedures / user	3.1	(3.0), [1 – 19]
30-Days prior to Encounter		
Initiated Care	101	74%
Reasonable Charges / user		
total	$3,266	(5,921), [1 – 48,694]
maximum procedure	$1,165	(1,818), [1 – 10,449]

Table 3: Demographic, Use of Inpatient and Outpatient Care, and Diagnoses of Study Patients

Category	Value/Num	Percent, (sd) [range]
Mean number visits /user	2.9	(2.2), [1 – 17]
Mean number clinic stops /user	4.5	(3.8), [1 – 24]
Mean number procedures /user	9.3	(8.2), [1 – 43]
30-Days after Encounter		
Initiated Care	103	76%
Reasonable Charges / user		
total	$4,862	(6,804), [63 – 37,608]
maximum procedure	$1,784	(2,277), [63 – 11,869]
Mean number visits /user	3.0	(2.1), [1 – 15]
Mean number clinic stops /user	4.8	(4.0), [1 – 23]
Mean number procedures /user	9.7	(7.9), [1 – 41]
Inpatient Care		
total reporting	136	
90-Days prior to Encounter		
Initiated Care	16	12%
Reasonable Charges / DRG	5,655	(2,559), [2,934 – 10,860]
Mean admissions /user	1.2	(0.6), [1 – 3]
Mean bedsections /user	1.6	(0.9), [1 – 4]
Mean days /user	3.6	(2.5), [1 – 8]
30-Days after Encounter		
Initiated Care	11	8%
Reasonable Charges / DRG	6,351	(2,853), [3,573 – 12,038]
Mean admissions /user	1.0	(0.0), [1 – 1]
Mean bedsections /user	1.6	(1.2), [1 – 4]
Mean days /user	6.2	(4.9), [2 – 17]
Diagnoses[2]		
total reporting	135	
On Encounter Date		
Number Diagnoses/classes	2.90	(1.87), [1 – 8]
90-day prior + 30 days after date		
Number Diagnoses/classes	7.10	(2.91), [1 – 13]
Diagnoses Classes		
Infectious (001-139)	25	19%
Neoplasm (140-239)	25	19%
Endocrine glands (250-259)	84	62%
Metabolic/Immunity (270-279)	67	50%
Blood/organs (280-289)	27	20%
Mental Disorders (290-319)	74	55%
Nervous/sense (320-389)	58	43%
Hypertensive (401-405)	88	65%
Heart disease (410-429)	47	35%
Circulatory system (430-459)	27	20%

Table 3: Demographic, Use of Inpatient and Outpatient Care, and Diagnoses of Study Patients

Category	Value/Num	Percent, (sd) [range]
Respiratory system (460-519)	32	24%
Digestive system (520-579)	48	36%
Genitourinary system (580-629)	39	29%
Skin (680-709)	24	18%
Musculoskeletal (710-739)	69	51%
Ill defined (780-799)	68	50%
Injury/poisoning (800-999)	19	14%

1 – VA defined priority levels 1-4.
2 – ICD-9 diagnoses classified by class based on three-digit codes. Congenital Anomalies (740-759) and Conditions Originating in Perinatal Period (760-779) were excluded.

Table 4: Computation of Supervision Summary and Component Scores

Index[1]	Symbol	Mean	S.D.	Range	R≠1[2] n	%	mean
RSI							
RSI-interaction	RSI_I	0.86	0.17	[0.25, 1.00]	70	50%	0.71
RSI-discussion	RSI_D	0.72	0.13	[0.25, 0.98]	140	100%	0.72
RSI-components							
Patient care							
indep'ly involved	t_{p0}	27.22	11.72	[5, 65]	140	100%	
involvement	R_{p1}	0.99	0.02	[0.82, 1.00]	2	1%	0.83
assistance	R_{p2}	0.94	0.12	[0.40, 1.00]	35	25%	0.76
observation	R_{p3}	0.98	0.06	[0.50, 1.00]	10	7%	0.81
absence	R_{p4}	1.00	*	[1.00, 1.00]	0		
Discussion							
contact	R_{do}	0.78	0.11	[0.50, 1.00]	135	96%	0.77
case-understand	R_{d1}	1.03	0.11	[1.00, 2.00]	15	11%	1.26
care-change	R_{d2}	1.18	0.22	[1.00, 2.00]	77	55%	1.33

1 – Definition of indices, computation formulas, and symbols key are provided in Table 1.
2 – R ≠ 1 indicates an interaction between the resident and supervisor.

Table 5: Adjusted[1] Impact of Selected Predictors on RSI index and Components

	Coefficient	Std Error	t	p
Primary Analyses				
Length GME training[2]				
RSI-interaction (R_I)	0.044	0.017	2.60	.011
care changed (R_{d2})	0.048	0.023	2.11	.037
case understand (R_{d1})	0.007	0.012	0.58	.56
contact (R_{d0})	-0.011	0.010	1.07	.29
observation (R_{p3})	0.000	0.007	0.43	.97
assistance (R_{p2})	0.022	0.011	1.97	.051
involvement (R_{p1})	0.002	0.002	0.76	.45
indep'ly involved (t_{p0})	-2.60	1.18	2.20	.030
Confirmatory Analyses				
Conditions: hypertension+circulatory disease				
RSI-interaction (R_I)	-0.138	0.065	2.10	.038
case understand (R_{d1})	-0.099	0.046	2.15	.033
assistance (R_{p2})	-0.165	0.044	3.71	<.001
indep'ly involved (t_{p0})	-9.452	4.390	2.15	.033
Conditions: Genitourinary system				
RSI-interaction (R_I)	0.059	0.044	1.34	.18
assistance (R_{p2})	0.060	0.030	2.04	.043
indep'ly involved (t_{p0})	8.13	2.93	2.78	.006
Number treated conditions[3]				
RSI-interaction (R_I)	0.002	0.007	0.32	.75
assistance (R_{p2})	0.015	0.005	2.83	.005
involvement (R_{p1})	-0.003	0.001	3.26	.001
indep'ly involved (t_{p0})	1.37	0.51	2.68	.008
Reasonable Charge Procedures[4]				
RSI-interaction (R_I)	-0.022	0.031	0.71	.47
contact (R_{d0})	0.055	0.019	2.85	.005
assistance (R_{p2})	-0.066	0.022	3.04	.003
Clinic Workload[5]				
RSI-interaction (R_I)	0.053	0.024	2.18	.031
assistance (R_{p2})	0.051	0.017	2.97	.004
Attending with advanced degree				
RSI-interaction (R_I)	0.074	0.045	1.65	.10
contact (R_{d0})	0.056	0.028	2.00	.048
indep'ly involved (t_{p0})	6.20	3.02	2.05	.041

Table 5: Adjusted[1] Impact of Selected Predictors on RSI index and Components

	Coefficient	Std Error	t	p
Patient private Insurance status[5]				
RSI-interaction (R_I)	0.075	0.027	2.74	.007
contact (R_{d0})	0.049	0.017	2.88	.005

1 – Adjusting for case complexity based on diagnosis of heart disease, hypertension, circulatory disorder, GI disorder, or inpatient admission during the past 90 days, patient private health insurance coverage, resident length in GME training and whether a US versus international medical school graduate, attending physician with an advanced master or doctorate degree in addition to medical degree, clinic workload based on number of procedures during day of index visit.

2 - Resident length of GME training computed by time in program in years.

3 - Number of ICD-9 conditions, aggregated into one of 17 disease classes, which were treated by the resident during the supervision encounter. Conditions in the same class were counted only once.

4 - The complexity of clinical procedure computed as the maximum Reasonable Charge among procedures performed during the patient encounter, with charges reported in $1,000 increments.

5 – Workload reported as number of procedures produced during the day in the given clinic, per 100.

Figure 1: Conceptual Framework of Resident Training

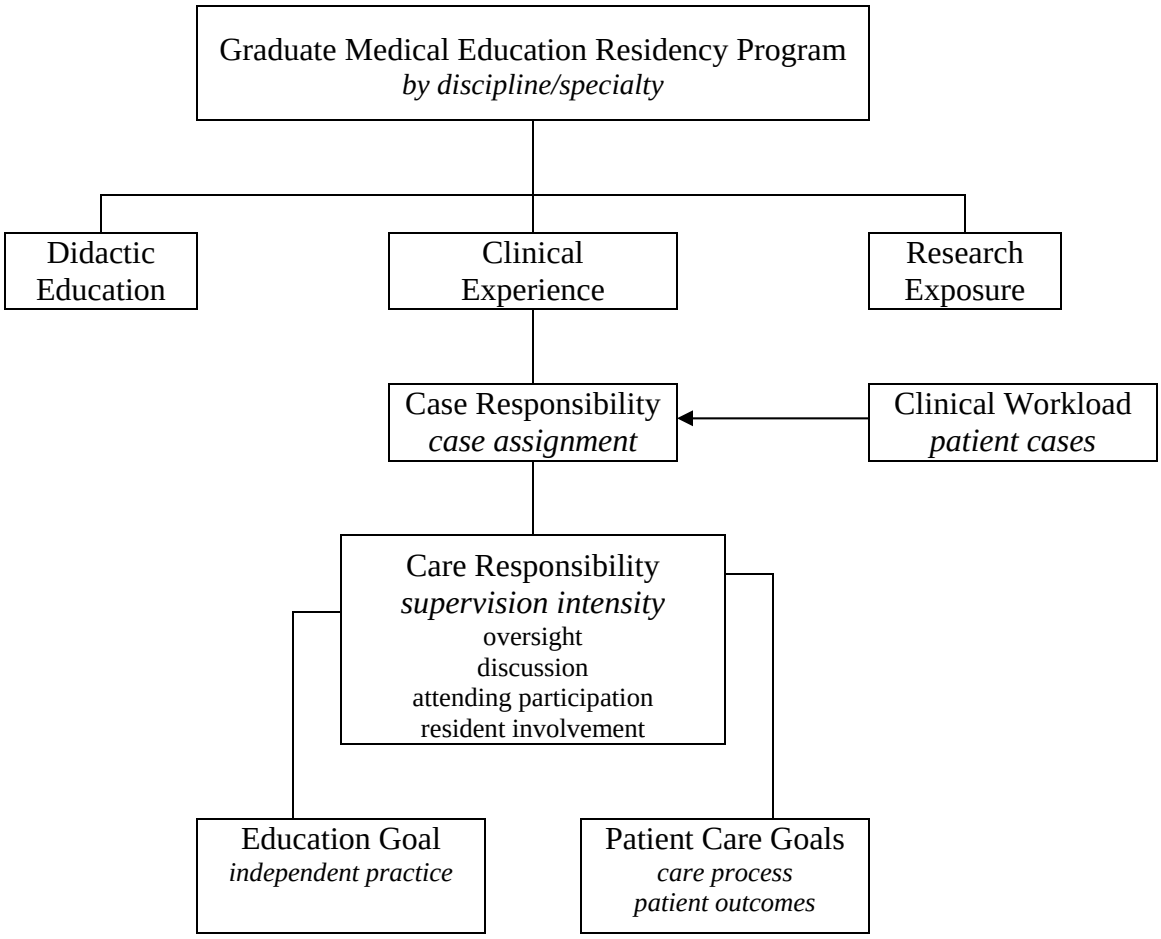


Figure 2a: Progressive Independence when Cases are Assigned with Progressive Case Responsibility

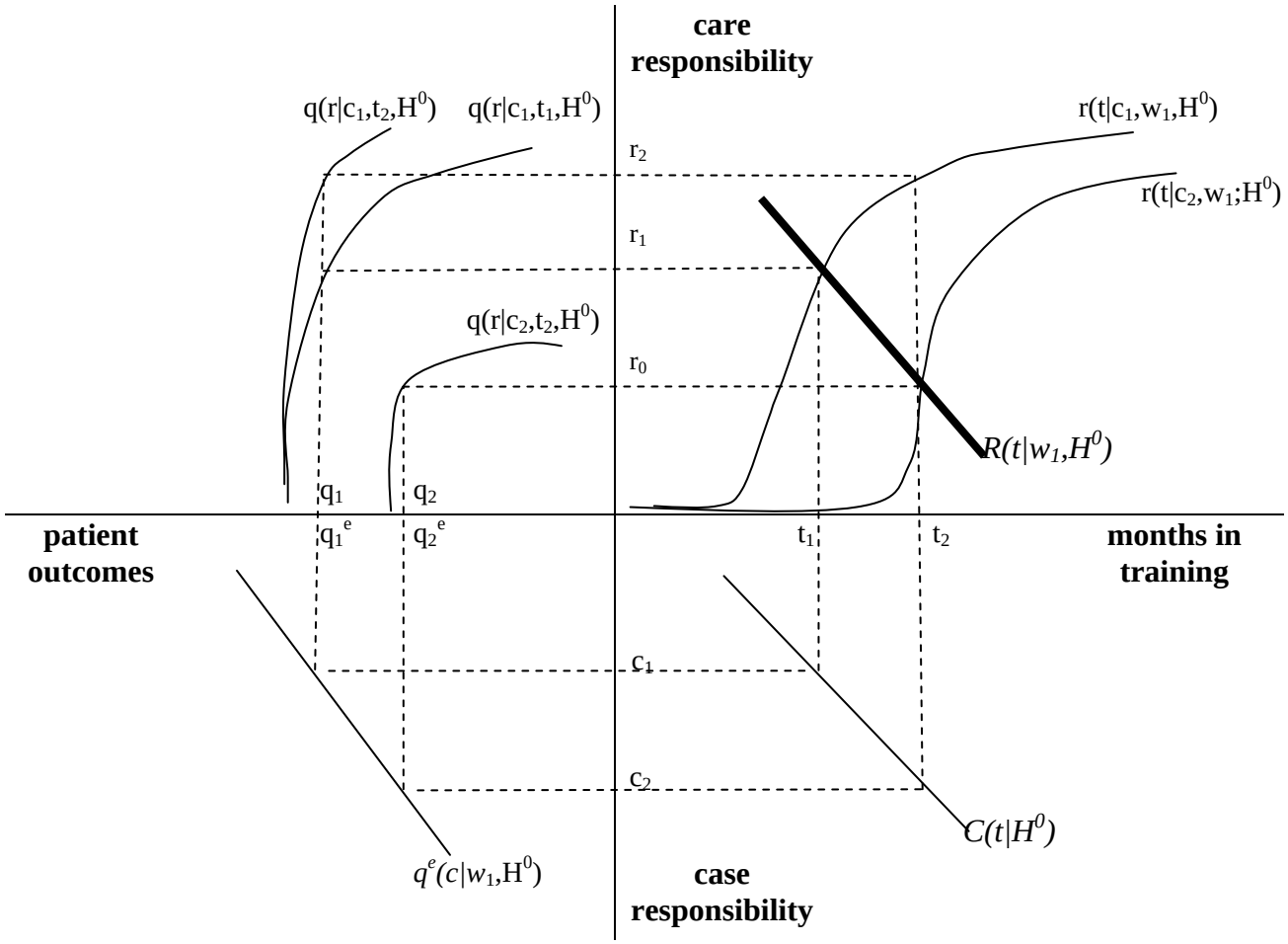
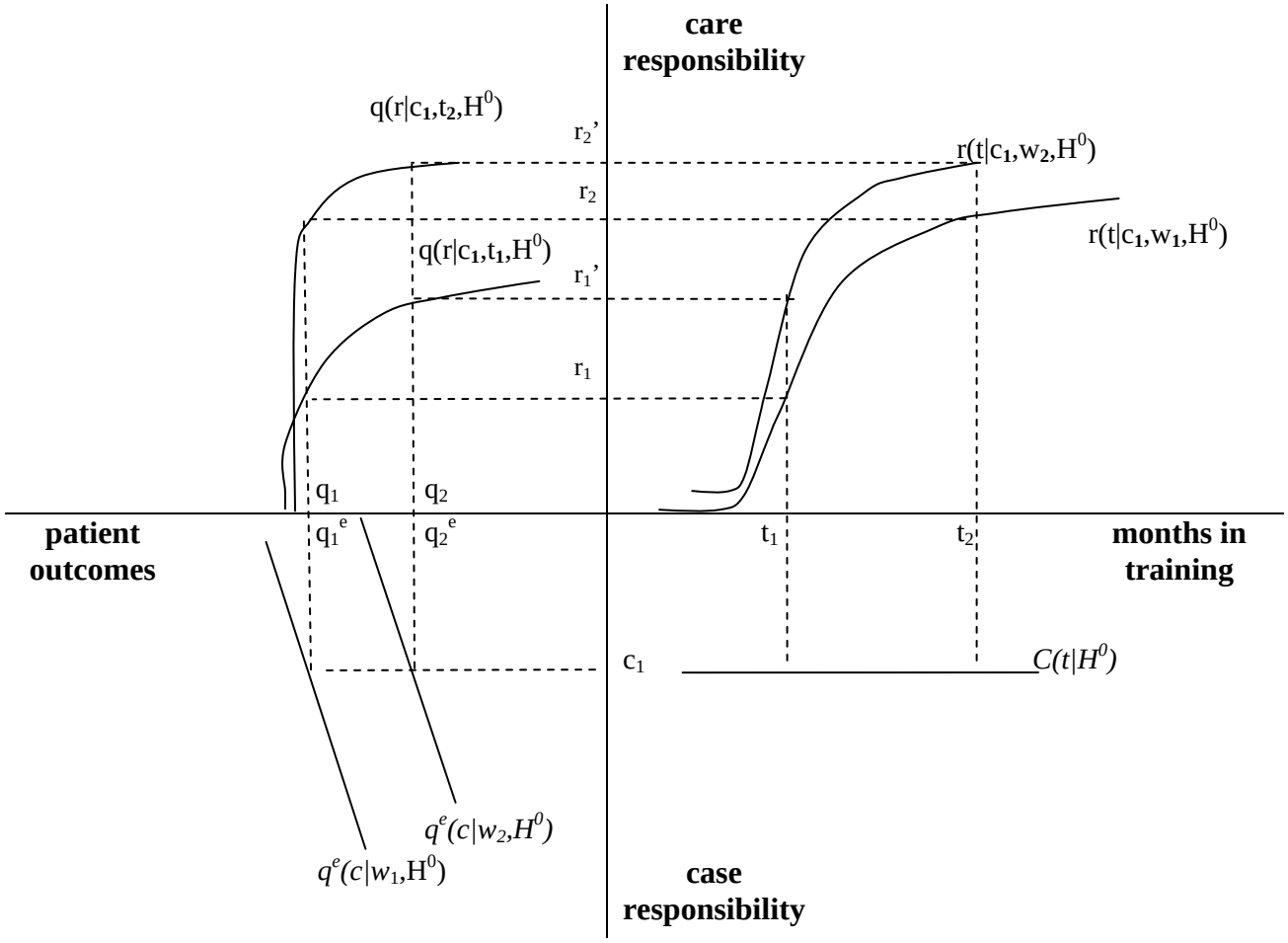


Figure 2b: Progressive Independence when Cases are Assigned at Random



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