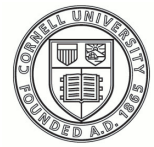

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Dissecting the Workforce and Workplace for Clinical Endocrinology, and the Work of Endocrinologists Early in Their Careers

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Abstract

[Excerpt] No national mechanism is in place for an informed, penetrating, and systematic assessment of the physician workforce such as that achieved by the National Science Foundation (NSF) for the periodic evaluation of the nation's scientists and engineers. Likewise, knowledge of the workforce for clinical research is enigmatic and fragmentary despite the serial recommendations of "blue-ribbon" panels to establish a protocol for the recurrent assessment of clinical investigators early in their careers. Failure to adopt a national system for producing timely, high-quality data on the professional activities of physicians limits the application of improvement tools for advancing clinical investigation and ultimately improving clinical practice.

The present study was designed as a pilot project to test the feasibility of using Web-based surveys to estimate the administrative, clinical, didactic, and research work of subspecialty physicians employed in academic, clinical, federal, and pharmaceutical workplaces. Physician members of The Endocrine Society (TES) were used as surrogate prototypes of a subspecialty workforce because of their manageable number and investigative tradition. The results establish that Web-based surveys provide a tool to assess the activities of a decentralized workforce employed in disparate workplaces and underscore the value of focusing on physician work within the context of particular workplaces within a subspecialty. Our report also provides a new and timely snapshot of the amount and types of research performed by clinically trained endocrinologists and offers an evidenced-based framework for improving the investigative workforce in this medical subspecialty.

Keywords

clinical research, physicians, workforce, data, surveys, endocrinologists

Disciplines

Endocrinology | Endocrinology, Diabetes, and Metabolism | Labor Economics | Labor Relations

Comments

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Commentary

Dissecting the Workforce and Workplace for Clinical Endocrinology, and the Work of Endocrinologists Early in Their Careers

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Context: The United States lacks timely reliable mechanisms for assessing the professional work of subspecialty physicians.

Objective: The aim was to use early-career members of The Endocrine Society as a model to estimate subspecialty physician involvement in patient care, teaching, research, and administration among clinical, academic, federal, and pharmaceutical/biotech workplaces and to assess the workforce for research within individual workplaces.

Methods: Physicians joining The Endocrine Society from 1991–2005 and residing in North America were invited to complete a Web-based survey. This report relies on 817 early-career endocrinologists or 29.6% of eligible respondents.

Results: Respondents from all types of workplaces engaged in patient care, teaching, research, and administration. The time committed to the four tasks, however, differed significantly among workplaces. Research (basic, translational, disease, patient, population, and prevention) was accomplished within all workplaces, but the scope and scale of investigative work was employer dependent. Recipients of National Institutes of Health K08/23 awards succeeded in receiving federal research project grants ($P < 0.001$). Respondents associated research with lowered incomes, a perception validated by an estimated drop in annual earnings of 2.8% per half-day spent on research ($P < 0.001$). Women in academic settings earned less than men ($P < 0.01$) and were less likely to occupy tenure-eligible positions ($P < 0.01$).

Conclusions: Web-based surveys offer a simple tool for estimating the work of subspecialty physicians and provide a framework for improving biomedical investigation. Several interventions should be considered for endocrinology: recruit physicians from underrepresented demographic groups, increase K08/23 awards, incentivize investigative careers, and improve the national infrastructure for biomedical research. **(*J Clin Endocrinol Metab* 96: 923–933, 2011)**

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For editorial see page 942

Abbreviations: AMC, Academic medical center; co-PI, coprincipal investigator; PI, principal investigator.

No national mechanism is in place for an informed, penetrating, and systematic assessment of the physician workforce such as that achieved by the National Science Foundation (NSF) for the periodic evaluation of the nation's scientists and engineers (1, 2). Likewise, knowledge of the workforce for clinical research is enigmatic and fragmentary despite the serial recommendations of "blue-ribbon" panels to establish a protocol for the recurrent assessment of clinical investigators early in their careers (3–5). Failure to adopt a national system for producing timely, high-quality data on the professional activities of physicians limits the application of improvement tools for advancing clinical investigation and ultimately improving clinical practice (6).

The present study was designed as a pilot project to test the feasibility of using Web-based surveys to estimate the administrative, clinical, didactic, and research work of subspecialty physicians employed in academic, clinical, federal, and pharmaceutical workplaces. Physician members of The Endocrine Society (TES) were used as surrogate prototypes of a subspecialty workforce because of their manageable number and investigative tradition. The results establish that Web-based surveys provide a tool to assess the activities of a decentralized workforce employed in disparate workplaces and underscore the value of focusing on physician work within the context of particular workplaces within a subspecialty. Our report also provides a new and timely snapshot of the amount and types of research performed by clinically trained endocrinologists and offers an evidenced-based framework for improving the investigative workforce in this medical subspecialty.

Subjects and Methods

Survey participants

TES is the primary professional organization dedicated to advancing the clinical practice of endocrinology in North America. The Society agreed to collaborate on an assessment of physician members early in their careers and to provide their e-mail addresses. Early-career members are defined as follows: they joined the TES between January 1, 1991, and December 31, 2005; they were 49 yr of age or younger on joining TES; they earned an M.D. or equivalent degree; they reside in Canada or the United States; and they hold an active license to practice medicine. We adopted this profile because internists/pediatricians in the United States complete fellowship training at about 34 yr of age (7), obtain National Institutes of Health (NIH) support for their first research grant at an average age of 44 yr (8), and function as principal investigators (PIs) or coprincipal investigators (co-PIs) for 5 yr or more.

We sent invitations to 3398 early-career physician members of TES, a cohort representing about 89% of internists/pediatricians trained in endocrinology, diabetes, and metabolism in the United States between 1991 and 2005 (9). A total of 641 individuals are excluded from this survey for reasons that follow: faulty e-mail address (n = 437), declined to participate (n = 89), started but failed to return a questionnaire or completed less than 75% of survey questions (n = 43), or lacked a license to practice medicine (n = 72). A total of 817 of the 2757 prospective respondents are included in this analysis, yielding a response of 29.6%.

The Survey Research Institute at Cornell University distributed materials to respondent e-mail addresses between February and April 2008. Participants submitted questionnaires anonymously over the Internet via a secure server. Participant instructions noted that the Council of TES approved the survey and that the Office for the Protection of Research Subjects, University of Illinois at Chicago, granted Institutional Review Board (IRB) approval for an exempt protocol. Respondent instructions explained that participation was voluntary, that respondent confidentiality would be maintained, and that none of the research conducted or published would divulge the responses of individual physicians.

Design and content of survey instrument

We tested a preliminary version of the questionnaire by inviting a random sample of 40 physician members to respond to a prototype of the questionnaire. We asked pilot survey participants to furnish written comments on any question they perceived to be ambiguous, awkward, or impertinent. Twenty-eight participants (70% response rate) provided remarks to reformat the questionnaire. Questionnaires returned by pilot volunteers are excluded from this report.

We asked participants to identify their employment sector: private practice (identified throughout as clinical care providers who own all or part of a solo/group practice or are employed by a group practice, health system, or hospital), academic (employed by a medical school or teaching hospital), federal government, or pharmaceutical and/or biotech industry. We requested that each respondent specify the number of half-days per week devoted to clinical service, teaching, research, and administrative work based on their supervisor's expectations, or themselves in the case of solo practitioners; designate the source(s) of salary support for time spent on research; and indicate their annual pretax compensation within ordered ranges. Survey instructions advised respondents to identify one or more research activities that best defined their investigative work over the past 12 months. The questionnaire allowed respondents to choose from an inclusive list of research activities (see Table 3) using definitions developed at a consensus conference on clinical research (10) and later improved by others (11, 12).

We asked a series of questions to examine the indifference to investigative careers. The questions relied on a five-point Likert scale (13), collapsed for analysis to three outcomes: agree, disagree, neither agree/disagree. A second set of questions considered proposals and awards for postfellowship research training and research project grants/contracts from PIs, co-PIs, or both. We invited respondents to designate their age, citizenship (Canada or U.S.), gender, and ethnic origin. We determined the ethnic backgrounds of physicians graduating from allopathic schools of medicine in the United States by estimating the mean fraction of each ethnic group earning an M.D. degree in 1991 to 2005 (7).

Statistical methods

Each questionnaire received a unique computer-generated case number to allow respondent identity to remain anonymous throughout the analysis of all data. Prospective estimates of sample size are based on those of Lansing and Morgan (14), and statistical analyses used software (version 6.0) distributed by Stata Corp. (College Station, TX).

Categorical variables are compared via Pearson's χ^2 goodness-of-fit-test. Statistical assessments of continuous variables are based on the ANOVA or a simple paired *t* test for between-group comparisons. We used a simple multiple regression model to test the association between the receipt of grants by PIs and co-PIs and other explanatory variables of research performance, and a Tobit regression model to determine the association between pretax earnings and various outcome measures to accommodate the censored earnings reported by respondents within specified ranges. We tested dependent variables with binary responses using a logit regression model. Some respondents failed to specify the number of half-days spent on research or provide information related to the submission of proposals for research project grants. The absence of a response, in 5.2% of cases, is assumed to be zero or identical to the "no" responses entered by most respondents. We justified this transformation on the basis that respondents who are uninvolved with research would overlook the need to verify a zero response.

Results

Respondent sample

Our results are based on a cohort of 817 physician members of TES from a sample of 2757 prospective respondents, yielding a response rate of 29.6%. Statistical estimates of sample size indicate that a response rate of 21.7% is consistent with achieving a confidence level of 95% for a survey with 2757 prospective participants. We tested the cohort of actual *vs.* prospective respondents to determine whether the year in which respondents joined TES and the fractions of respondents residing in Canada and the United States differed in the two populations. Test results established that the distributions of actual and prospective respondents are similar ($P > 0.25$), an indication that the respondent cohort is representative of early-career endocrinologists identified for this study.

Respondent profile

The fractions of Canadian and U.S. respondents are 5 and 95%, respectively. The distribution of citizens, permanent residents, and noncitizens from the United States is 86, 8, and 6%, respectively; and the ratio of women to men is 48:52. We merged the responses of endocrinologists from the United States and Canada, except when specified, because every measured aspect (age, gender, education) of their profiles is indistinguishable ($P > 0.50$) based on multiple statistical estimates.

A respective 11.4 and 21.9% of respondents earned baccalaureate and M.D. or equivalent degrees outside of North America. In contrast, a respective 96.6 and 99.3% of respondents completed residency and fellowship training in North America. Respondents earned baccalaureate degrees at 21.6 ± 0.1 (mean ± SEM) yr of age, graduated from medical school at 26.7 ± 0.1 yr of age, and finished fellowship training at 33.1 ± 0.1 yr of age. Over 97% of respondents are board certified or board eligible in either adult or pediatric endocrinology, an indication that the clinical training of the respondent sample is uniform. The ratio of internists to pediatricians in the respondent sample was 3:1, a proportion consistent with the number of physicians trained in endocrinology, diabetes, and metabolism in 1991–2005 (9).

We compared the self-identified ethnic backgrounds of U.S. respondents with those of physicians graduating from allopathic schools of medicine in the United States (Table 1). The self-identified fraction of Native American, Asian, Caucasian, and Hispanic/Latino respondents approximate those of graduates from U.S. schools of medicine. The fraction of Black or African-American endocrinologists, in contrast, is underrepresented by an absolute difference of 3.7% when compared with the mean of Black or African-American physicians graduating in 1991 to 2005.

Workplace assessment

The results indicate that clinical care providers, for instance, devote 7.8 half-days/wk to clinical service. The clinical service obligations of academic, federal, and pharmaceutical respondents, by comparison, are less ($P < 0.01$), averaging 3.6, 2.8, and 1.0 half-days/wk, respectively (Table 2).

Endocrinologists from all workplaces participate in teaching medical students, residents, or fellows. The didactic commitments of academic and federal respondents, however, are greater ($P < 0.05$) than those from other employment sectors (Table 2).

Turning to investigative work, clinical care providers spend 1.9 half-days/wk on research. Respondents from academic, federal, and pharmaceutical/biotech workplaces, by comparison, spend 5.1, 5.7, and 7.5 half-days/wk, respectively, on research (Table 2). Administrative responsibilities including committee assignments require 1.0 half-day/wk among clinical care providers; 1.4 and 1.2 half-days/wk in the academic and federal workplaces, respectively; and 2.8 half-days/wk in the pharmaceutical/biotech industry (Table 2).

Workforce analysis

We examined the amount and types of investigative work pursued within all employment sectors: clinical service, academic, federal, and pharmaceutical (Table 3). An

TABLE 1. Self-identified ethnic backgrounds of clinically trained members of TES, early in their careers, and graduates of allopathic schools of medicine in the United States

Ethnic background	Self-identified backgrounds (mean %)[a]			Graduates of U.S. medical schools (%)[b]
	Women	Men	Both genders	
American Indian or Alaskan Native	0.3	0	0.1	0.7
Asian-American	21.8	16.2	18.9	16.9
Black or African-American	3.2	2.5	2.8	6.5
Caucasian	65.5	72.8	69.3	68.7
Hispanic or Latino-American	6.2	5.0	5.6	6.4
Multiethnic	0.8	0.7	0.8	Unreported
Other: unknown or unreported[c]	2.2	2.7	2.5	0.8

[a] Each value is expressed as the mean percentage of responses reported by 374 women (48.1%) and 403 men (51.9%) out of a total 777 graduates of allopathic schools of medicine in the United States.

[b] The ethnic backgrounds of medical school graduates were determined by estimating the mean number of individuals, within specified ethnic groups, graduating from allopathic schools of medicine from 1991 to 2005 (7). An average of 15,713 students graduated per year between 1991 and 2005, the same 15-yr sample window adopted for the present survey of clinically trained endocrinologists early in their careers.

[c] The fraction of individuals that self-identified as "other" may include respondents from ethnicities that were unlisted (Hawaiian Native, Pacific Islander) in the survey instrument or individuals whose ethnicity is unknown or undisclosed.

estimated 35.9% of respondents from the clinical care workplace reported research efforts, albeit at efforts that are more modest than workplaces offering protected research time (Table 3). Patient-oriented studies are pursued by about 21.2% of clinical care providers, an effort 4-fold greater than other research activities ($P < 0.01$). A respective 5.1 and 4.5% of the clinical care providers are concerned with population- and disease-oriented work. Basic-, translational-, and prevention-oriented research is pursued by clinical care providers, but on the order of 3.2 to 0.6% (Table 3).

Respondents affiliated with the federal workforce reported a research commitment of 87.5%. Disease-oriented research is a priority among federal respondents ($P < 0.05$), involving 28.1% of this workforce. Federal respondents report similar commitments ($P > 0.15$) to translation-,

TABLE 2. Assessment of the number of half-days per week devoted to clinical service, teaching, research, and administration among all types of workplaces employing clinically trained members of TES

Activity	Time commitment in half-days/wk[a]			
	Clinical care providers[b]	AMC or teaching hospital[c]	Federal government (HHS/DOD/VA)[d]	Pharmaceutical biotech/industry
Clinical service	7.8 ± 0.2 (69.1)	3.6 ± 0.1 (31.4)	2.8 ± 0.4 (26.6)	1.0 ± 0.4 (8.8)
Teaching[e]	0.8 ± 0.1 (6.6)	1.4 ± 0.1 (11.6)	1.5 ± 0.1 (13.5)	0.3 ± 0.1 (2.4)
Research	1.9 ± 0.1 (16.9)	5.1 ± 0.2 (45.2)	5.7 ± 0.6 (49.6)	7.5 ± 0.5 (67.2)
Administration[f]	1.0 ± 0.1 (7.4)	1.4 ± 0.1 (11.8)	1.2 ± 0.2 (10.3)	2.8 ± 0.6 (21.6)
Total	11.3 ± 0.2	11.4 ± 0.1	11.3 ± 0.5	11.7 ± 0.7

Data are expressed as mean ± SEM (percentage effort).

[a] Each value is expressed as the mean ± SEM of half-days per week reported by 760 respondents from a total of 817 survey participants. The number of respondents within each employment sector is as follows: 288 clinical care providers, 411 AMCs, 31 federal, and 30 pharmaceutical/biotech. Note that the "total" half-days per week deviate from the expected value of 10; values were not normalized to 40 h/wk to allow the data to reflect the effort reported for each workplace. The percentage effort (shown in *parentheses*) allows comparisons within and among workplaces. Respondents were asked to specify the half-days per week devoted to each of the indicated activities during the 12 months preceding the survey based on the time they negotiated with their supervisors or themselves in the case of practitioners in a solo or group practice. The results provide an estimate of the time/effort reported for a putative 40-h work week because respondents were advised to exclude "off-the-clock" commitments for any activity that might be accomplished after normal working hours or on weekends, holidays, or vacation periods.

[b] Clinical care providers refer to respondents that are private practitioners and are owners/partners of a solo or group practice, or are employed by a group practice, health system, or hospital.

[c] AMC refers to respondents employed at any medical school or teaching hospital accredited to sponsor a residency program in internal medicine or pediatrics, or a fellowship program in adult or pediatric endocrinology, or both as approved by the Accreditation Council for Graduate Medical Education (http://www.acgme.org).

[d] Federal government includes all respondents employed by the Department of Health and Human Services (HHS), Department of Defense (DOD), or the Department of Veterans Affairs (VA).

[e] Includes the total time devoted to teaching medical students, residents, or fellows.

[f] Includes the total time devoted to administrative work including committee assignments.

TABLE 3. Dissection of employers and the investigative work pursued by clinically trained members of TES early in their careers

Type of investigative work	Workplace and/or employer (%)[a]			
	Clinical care provider[b]	Federal government (HHS/DOD/VA)[c]	Pharmaceutical or biotech industry	AMCs[d]
None	64.1	12.5	9.3	9.8
Basic	0.6	12.5	9.3	13.9
Translational	1.3	20.3	14.8	16.1
Disease-oriented	4.5	28.1	13.0	21.3
Patient-oriented	21.2	15.6	40.7	22.9
Population-oriented	5.1	4.7	11.4	9.8
Prevention-oriented	3.2	6.3	1.9	6.2

[a] Each value is expressed as the mean percentage of work pursued by clinically trained endocrinologists within all types of workplaces. Respondents consisted of 386 women (48.3%) and 414 men (51.7%) providing a total of 800 responses from 817 participants. The total number of respondents within each employment sector is as follows: 304 clinical care providers, 433 AMCs, 32 federal, and 31 pharmaceutical/biotech. The 800 respondents identified a total of 1215 research activities. Respondents were allowed to specify one or more of the designated activities to reflect the type(s) of investigative work pursued in the 12 months preceding the survey. Individuals designating two lines of investigative work were assumed to spend 50% effort on each endeavor, those designating three lines were assumed to spend 33.3% effort on each endeavor. No respondent pursued more than three types of investigative work. Research activities were defined using terminology adopted by others (10–12), and appeared as follows in the survey questionnaire: basic research—laboratory-based research involving the development of new drugs, technologies, or devices; translational research—bench to bedside or bidirectional research involving human subjects known to the investigator [use of human specimens (cells/tissues) for laboratory studies was excluded]; disease-oriented research—requires use of human subjects to investigate the mechanisms or natural history of disease, or improve the detection or diagnosis of disease; patient-oriented research—clinical trials, including phase I, II, III, IV trials of drugs, biologics, devices, and the evaluation of therapeutic interventions; population-oriented research—outcome studies of populations, health services, and cost effectiveness research, studies of health quality including best practices and medical errors, epidemiology and genetic studies, and community-based clinical trials; and prevention-oriented research—primary and secondary prevention of disease in patients and health promotion via behavioral modification.

[b] Clinical care providers refer to respondents that are owners/partners of a solo or group practice, or are employed by a group practice, health system, or hospital.

[c] Federal government includes all respondents employed by the Department of Health and Human Services (HHS), Department of Defense (DOD), or the Department of Veterans Affairs (VA).

[d] AMCs refers to respondents employed by any medical school or teaching hospital accredited to sponsor a residency program in internal medicine or pediatrics, or a fellowship program in adult or pediatric endocrinology, or both as approved by the Accreditation Council for Graduate Medical Education (http://www.acgme.org).

patient-, and basic-oriented research as indicated by respective efforts of 20.3, 15.6, and 12.5%. A respective 4.7 and 6.3% of federal respondents are involved in prevention- and population-oriented studies (Table 3).

About 90.7% of the pharmaceutical/biotech workforce is involved in research (Table 3). Patient-oriented studies prevail among industrial respondents, as indicated by commitments of 40.7% ($P < 0.01$). Participation in translation-, disease-, population-, and basic-oriented research is comparable ($P > 0.25$), as noted by respective efforts of 14.8, 13.0, 11.4, and 9.3%. Prevention research is limited to 1.9% within the pharmaceutical/biotech workforce (Table 3).

The research activities of academic respondents differ from those of other workplaces. Respondent interest in patient-, disease-, translation-, and basic-oriented studies, for instance, is distributed rather uniformly, with efforts ranging from 13.9 to 22.9% (Table 3). Population- and prevention-oriented studies involve a respective 9.8 and 6.2% of academics. Only prevention research ranks below other research activities ($P < 0.05$). We considered the possibility that mean research time within the academic workplace may be confounded by disproportionate numbers of academics with clinical service commitments of 80% or more. This outcome is unlikely because respondent time commitments—for all tasks—are normally and randomly distributed within and among employment sectors, and estimates of the variance are consistent within and among employment sectors as determined by the SEM (Table 2).

Research funding

We examined the sources of extra- and intramural funds used to pay a portion of respondent salaries for time spent on research. The estimates are independent of personal compensation but establish the fraction of respondents that rely on extra- or intramural funds to pursue research (Table 4).

We found that 27.7% of respondents used grants/contracts awarded by federal, industrial, or philanthropic sources to defray portions of their salaries for time spent on research. The remaining 72.3% of respondents have intramural funds to cover a portion of their salaries for time spent on research. Intramural funding sources in-

TABLE 4. Analysis of proposals submitted and awards received by clinically trained members of TES early in their careers for postfellowship research training and research project grants

Type of proposal or grant award	Sources of funding available to clinically trained endocrinologists						
	HHS[a]						
	NIH	Other HHS[b]	VA[a]	DOD[a]	Philanthropy	Industry	Other
Training (post fellowship)							
Proposals submitted (%)	44.4	3.2	5.7	2.0	22.3	15.7	6.7
Proposals/applicant[c]	1.8 ± 0.1	1.8 ± 0.5	2.1 ± 0.2	2.0 ± 0.4	1.8 ± 0.1	2.3 ± 0.2	1.8 ± 0.3
Success/applicant (%)	20.1	11.8	80.0	28.6	NA	NA	NA
Research as PI							
Proposals submitted (%)	38.1	3.1	2.7	2.3	27.4	19.1	7.3
Proposals/applicant[c]	2.8 ± 0.2	2.1 ± 0.6	1.9 ± 0.3	2.2 ± 0.4	2.9 ± 0.2	2.7 ± 0.2	2.3 ± 0.3
Grants /applicant[c]	2.1 ± 0.1	1.3 ± 0.3	1.7 ± 0.3	1.8 ± 0.6	2.0 ± 0.2	2.3 ± 0.2	2.0 ± 0.2
Success/applicant (%)	48.4	33.3	42.1	56.3	53.5	76.9	73.6
Research as Co-PI							
Proposals submitted (%)	62.7	0.5	3.7	1.4	13.1	12.5	6.1
Proposals/applicant[c]	2.3 ± 0.2	1.0 ± 0.0	2.0 ± 1.0	1.0 ± 0.0	1.4 ± 0.1	1.8 ± 0.3	1.8 ± 0.4
Grants/applicant[c]	1.6 ± 0.1	1.0 ± 0.0	1.0 ± 0.0	1.0 ± 0.0	1.0 ± 0.0	1.8 ± 0.3	1.4 ± 0.3
Success/applicant (%)	51.1	100	28.6	100	50.0	96.3	58.2

NA, Data not available.

[a] Federal departments: NIH, National Institutes of Health; HHS, Department of Health and Human Services; VA, Veterans Affairs; DOD, Department of Defense.

[b] Other HHS departments: Agency for Healthcare Research and Quality, Centers for Disease Control and Prevention, Food and Drug Administration, Health Resources and Services Administration, and Substance Abuse and Mental Health Services Administration.

[c] Values are expressed as mean percentage or the mean ± SEM. The submission of postfellowship training proposals is based on 202 applicants out of a total of 817 respondents (24.7%) that produced 687 proposals for consideration by federal and nonfederal agencies. A total of 166 individuals out of 817 respondents (20.4%) produced 305 applications for NIH K-series awards. Estimates for research project grants are based on a total of 940 proposals submitted to federal and nonfederal agencies by 167 PIs out of 817 respondents (20.5%) and a total 230 proposals produced for consideration by federal and nonfederal agencies by a cohort of 82 Co-PIs from a total sample of 817 respondents (10.1%).

clude: clinical earnings, 24.7%; medical schools and/or hospitals, 21.3%; and endowments or other sources, 9.3%. Federal and pharmaceutical/biotech employers support the full salaries of 13.2 and 3.8% of respondents, respectively.

We examined the number of proposals submitted and grants/contracts awarded to endocrinologists (Table 4). An estimated 24.7% of endocrinologists produced proposals for postfellowship research training from federal and nonfederal sources. Respondents submitted an average of 1.8 proposals for NIH K08/23 awards, with a success rate of 20.1% (Table 4). We tested, by multiple regression, whether an association exists between receiving a K08/23 award and explanatory variables: gender, years post fellowship, and the receipt of federal research project grants as either a PI or co-PI. A decided association is evident ($P < 0.001$) between receiving a K08/23 award and the subsequent receipt of research project grants from federal and nonfederal agencies as a PI, but not as a co-PI. The association between K08/23 awards and research project grants is independent of gender but dependent on postfellowship experience ($P < 0.001$).

Respondents submitted a total of 1170 proposals for research project grants as PIs and co-PIs (Table 4). Prospective PIs produced an average of 2.8 proposals for consideration by NIH and received an average of 2.1 awards, a career success rate of 48.4% (Table 4). Applications submitted to the Veterans Administration and Department of Health and Human Services agencies (excluding NIH) are as successful as those considered by NIH (Table 4). The success rate of proposals considered by philanthropy and industry is 53.5 and 76.9%, respectively (Table 4). Applications for research project grants involving co-PIs are as successful ($P > 0.15$) as those produced by PIs (Table 4).

Research commitments: individuals and institutions

We queried respondents about their enthusiasm for investigative careers as first-year medical students, residents, or fellows. The proportion of positive responses (yes) increased from 38.7% as medical students to 60.0% as residents and 74.3% as fellows. We asked whether respondents were aware of opportunities to pursue faculty-sponsored research projects. Positive responses (yes) increased from 26.2% as medical students to 27.9% as residents and 75.2% as fellows. We tested whether first-year residents and fellows are coached or encouraged to participate in faculty-directed research. We found that 27.3% of respondents reported being encouraged to participate in faculty research as residents, whereas 69.3% were encouraged similarly as fellows.

We evaluated the institutional resources available to respondents to pursue investigative work as fellows. Approximately 53.4% of respondents accessed institutional support to prepare IRB protocols as fellows, 60.0% used institutional facilities for the acquisition/management of clinical data, and 71.3% relied on institutional core facilities for laboratory and clinical research. Only 51.0% of respondents, however, had access to administrative support to produce applications for postfellowship research training grants and/or research project grants as fellows.

We determined the investment made by academic medical centers (AMCs) in junior faculty by asking respondents to specify the total dollar value of support they received for personnel, equipment, supplies, and other research expenses. The results indicate a linear relationship between the number of half-days per week devoted to research and institutional investments made to support the nascent research programs of early-career academics (Fig. 1, *top*).

We asked respondents employed by AMCs whether their institution granted tenure and whether they held a tenure-eligible post. Tenure opportunities were limited to 50.0% of AMCs, and 40.1% of female and 59.9% of male respondents were appointed to tenure-eligible faculty positions. Gender disparity is evident ($P < 0.01$) when the regression model controlled for total time worked, half-days per week spent on research, type of employer, and years post fellowship.

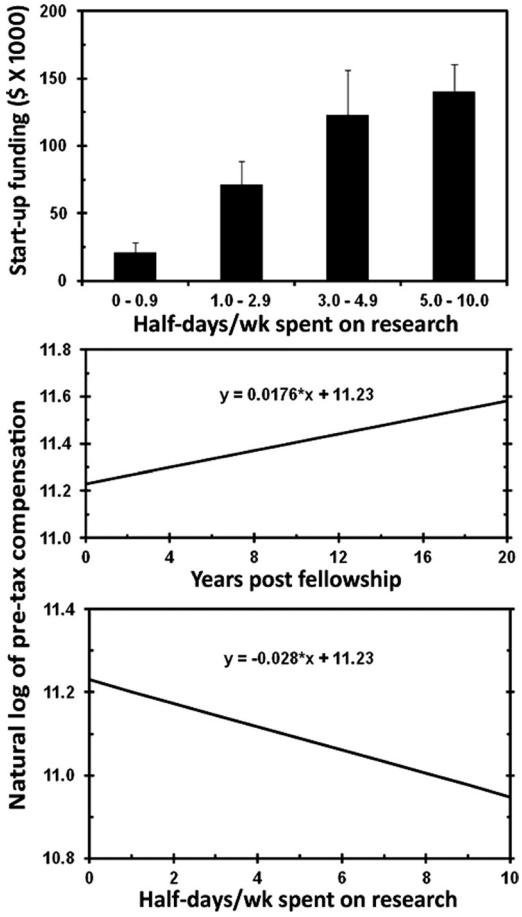

FIG. 1. *Top*, Each bar designates the mean ± SEM of institutional funds (in constant dollars) provided over 3 yr to 411 clinically trained endocrinologists employed at AMCs as a function of half-days per week devoted to research. *Middle*, The equation/line describes the relationship between years of postfellowship experience for 411 clinically trained endocrinologists (employed at AMCs) and mean annual earnings. Mean pretax earnings increased by 1.8% per year for each year of postfellowship experience based on a Tobit regression model. *Bottom*, The equation/line describes the relationship between half-days per week devoted to research and mean annual earnings. Mean pretax earnings decrease by 2.8% per year for each half-day per week spent on research among 411 early-career clinical endocrinologists employed at AMCs, based on a Tobit regression model.

Restraints on investigative careers

Approximately 69.7% of respondents reported that researchers receive less compensation than clinical care specialists ($P < 0.01$). Similarly, 70.1% of respondents noted that research careers are unattractive relative to those involving clinical care because of expectations to produce publications and obtain extramural research support ($P < 0.01$). About 58.8% of respondents note that job uncertainty is a significant issue for researchers *vs.* a career in the clinical service sector ($P < 0.05$). Only 50.3% of respondents considered that the time and energy for pursuing a successful career in research exceeded that required for a successful career focused on clinical care.

We tested the perceived earnings differential involving investigative careers among physicians at AMCs by using a regression model specifying the natural logarithm of pretax annual earnings as a function of two key explanatory variables (years post fellowship and half-days per week devoted to research), as well as variables to control for gender, type of employment, and total work hours per week. The results demonstrate that the pretax annual earnings of endocrinologists affiliated with AMCs increase linearly, averaging 1.8% per year of postfellowship experience (Fig. 1, *middle*). The annual compensation of women in this cohort, however, is about 22.1% below that of men ($P < 0.01$), based on a similar regression model designating the natural logarithm of pretax annual earnings as a function of a dichotomous variable for gender, in addition to total time worked per week, half-days per week spent on research, type of employer, and years post fellowship. Lastly, we used a regression model stipulating the natural logarithm of pretax annual earnings as a function of one explanatory variable (two or more half-days per week devoted to research), as well as variables to control for gender, total time worked, type of employer, and years post fellowship. The results establish that annual earnings drop by 2.8% for each half-day per week spent on

research ($P < 0.01$) relative to respondents spending 1 half-day/wk or less on research (Fig. 1, *bottom*). The annual earnings loss of women and men are similar if they spend 2 or more half-days/wk on research. Based on our model (Fig. 1, *bottom*), respondents devoting 3 half-days/wk to research with pretax earnings of $135,000/yr would earn about $1,134 less than counterparts spending 1 half-day/wk or less on research.

Discussion

This study relied on physician members of TES to evaluate the feasibility of using a Web-based survey tool for assessing the professional work of early-career physicians within a medical subspecialty. The findings provide fresh insights about the work of early-career endocrinologists, document the clinical commitments and research accomplished within all types of workplaces, and extend knowledge about the challenges limiting the pursuit of investigative careers among clinically trained endocrinologists.

Our estimates of the half-days per week devoted to clinical service, teaching, research, and administration offer a contemporary snapshot of the professional responsibilities of physician endocrinologists (Table 2) and demonstrate that the percentage effort devoted to individual tasks is employer dependent (Table 3). A novel aspect of these findings emerges from considering the extent and type of research accomplished within individual workplaces.

Research of all types (basic, translational, disease, patient, population, and prevention) is accomplished within each workplace, but the interest in particular pursuits is emblematic of individual employment sectors. Within the clinical care workplace, for instance, patient-oriented research prevails by 4- to 5-fold over other research. The implication embedded in this finding is that clinical care providers participate in one or more types of patient-oriented research involving practice-based research networks, patient registries for cohort studies, and patient enrollment in multicenter trials of new drugs and procedures or both. For reasons of practicality, the survey questionnaire did not ask clinical care providers to differentiate among the specified investigative approaches. It seems reasonable to suggest, however, that clinical care providers likely collaborate in one or more patient-oriented protocols developed and funded through AMCs, federal, or industrial sponsors because the time available for research represents about 16.0% of their total professional effort (Table 2).

Other evidence that workplaces shape research pursuits is based on the profile of investigative activities observed within academic, federal, and pharmaceutical sectors (Table 3). Note that patient-oriented research is the principal activity within pharmaceutical workplaces, exceeding other types of research by about 3-fold. Research interests within the federal and academic sectors, in contrast to other workplaces, are distributed rather uniformly, except for the minimal involvement in population and prevention studies.

Respondent participation in prevention-oriented research, compared with other research activities, is trivial among all workplaces (Table 3). We did not determine why respondents are uninvolved in prevention research, but the meager fraction of involved endocrinologists merits the consideration of stakeholders in clinical research—academic, federal, industrial, philanthropic, and professional. The unequivocal gap in prevention studies in endocrinology provides a singular opportunity for stakeholders to champion interventions for improving prevention-oriented research. Opportunities for preempting endocrine disorders are burgeoning (15–18), and compelling new strategies are available to investigate risk assessment, disease tracking, and personalized therapy (19). Enlarging investments in the training and conduct of prevention-oriented research would facilitate the transformation of clinical endocrinology from a curative to preventive focus with an emphasis on preemptive medicine and personal health care planning (19).

The analysis of proposals produced by early-career respondents uncovered a compelling association between receiving an K08/23 award and the subsequent receipt of federal research project grants as a PI, but not as a co-PI. We did not consider all of the variables needed to predict the long-term success of K-awardees as future recipients of federal research grants (20, 21). But, the robust correlation ($P < 0.001$) between K08/23 award recipients and research project grants suggests increasing the number of K08/23 awards to bolster interest in prevention- and population-oriented research (Table 3).

Our assessment of the academic workforce indicates that endocrine-related research within AMCs is leveraged largely on intramural as opposed to extramural funds. This conclusion is based on finding that 72.3% of academic endocrinologists rely on intramural funds to cover portions of their salaries for time spent on research, whereas only 27.7% of academics reported salary support from extramural grants/contracts. Dissection of intramural funding streams revealed that clinical earnings accounted for almost 25% of the salary support of early-career academics, or about the same level of salary support derived from extramural grants/contracts. Although AMCs are committed to supporting the research activities of newly appointed clinical faculty, significant portions of the investigative enterprise remain vulnerable

to unpredictable changes in health care reimbursement. In addition, postfellowship research training in the form of K08/23 awards is limited to an estimated 4.0% of respondents (Table 4).

Beyond the set of constraints identified above resides an anachronistic, ailing, and highly fragmented federal-institutional partnership for supporting clinical research (11, 22, 23). For instance, assessments of extramural research funding among individual institutes within NIH highlight the difficulty of supporting clinical research in general and a lack of enthusiasm for population-oriented research within certain institutes (24). Furthermore, a disparity approaching 2:1 has prevailed for funding basic *vs.* clinical research across NIH (25, 26). The summed challenges confronting the academic workforce and those within the federal-institutional partnership provide the rationale for proposing stakeholder interventions to improve clinical research on endocrine disorders through predictable, sustained, and prudent support of clinically oriented investigative work. The thrust embedded in the proposed intervention is to discreetly enlarge the fraction of physician endocrinologists with postfellowship research experiences (K-awardees) so they can, in turn, gain extramural support for research project grants and have access to the time and funds to pursue investigative careers.

Our assessment of the ambivalence surrounding investigative careers revealed that respondents perceived a significant fiscal penalty for participating in research. We verified this perception by showing that pretax annual earnings of academic investigators fall by 2.8% for each half-day per week devoted to research (Fig. 1, *bottom*). Women and men in academic careers share the earnings adjustment for research time equally. The annual compensation of female respondents in academic settings, however, is 22% below that of males, a well-documented earnings disparity among women physicians (27, 28). Approximately two thirds of respondents identified job uncertainty in the academic sector as a significant limitation for pursuing investigative careers. This perception is consistent with the persistent erosion in tenure-track appointments for clinical faculty employed by AMCs (29) and parallels the career uncertainties voiced by academic pulmonary physicians early in their careers (30).

The self-identified ethnic backgrounds of survey respondents approximate those of physicians graduating from allopathic schools of medicine in the United States between 1991–2005 (Table 1). One noteworthy disparity exists, however. The fraction of Black or African-American endocrinologists is about 3.7% below the mean set by graduates of the nation's medical schools (Table 1). This issue merits deliberate and resolute attention of training programs in clinical endocrinology. It also impacts endocrine-based clinical research because the ethnic background of physicians directing clinical protocols shapes the ethnic profile of volunteers agreeing to participate in a clinical trial or study (31). Participation of underrepresented ethnic groups in clinical trials and studies is essential (32, 33) because reliable estimates of the safety and efficacy of new and existing drugs or treatments are unachievable unless the subjects enrolling in clinical trials mirror the demographic norm of the U.S. population at large (31). The need to reconcile ethnic disparities in the future workforce for endocrinology is a pressing concern requiring interventions for the delivery of clinical care to all demographic groups (34–36).

This study has several strengths and limitations. From the standpoint of strengths, the findings indicate that Web-based surveys offer a mechanism to deconstruct the professional work of subspecialty physicians with an eye toward the application of improvement tools for testing explanatory variables and developing interventions to improve clinical investigation and its practitioners. Access to timely data within a clinical subspecialty fills a void occasioned by the lack of a national protocol for pinpointing deficits in the scope and scale of clinical research.

From the perspective of weaknesses, surveys rely on self-reported estimates of individual performance and personal experience. The credibility and validity of survey data are well documented, given that questionnaires adhere to the general principles of survey design (37). Survey effectiveness is limited by respondent participation. The 29.6% participation in this study exceeded the 95% level of confidence, but a more robust response rate would extend confidence in the findings and the generalizations derived from them. Improvements in response rates may be achieved through presurvey communications with prospective respondents, and by a follow-up telephone call to nonresponders. The cross-sectional design adopted for this study limits the power of this report because the design lacks controls for establishing cause-and-effect relationships. This study was undertaken as a pilot project to inform the design of future assessments and permit hypotheses to be tested based on the findings presented here. Our workforce assessments, for instance, are limited by the absence of background variables defining the specific types of the clinical, didactic, investigative, and administrative activities pursued by respondents. In the same vein, additional background information about employers would offer greater insight about respondent work within all employment sectors: academic, clinical care, federal, and pharmaceutical/biotech. The need to capture additional background variables, however, is a challenge because surveys involving physicians are best limited to 10 min of respondent effort. Finally, our results are based on

a time horizon ranging from 1991–2005, an interval recognized for the generous support for research.

The present assessment provides a benchmark for estimating the scope and setting of workplace activities pursued by early-career physician members of TES or other endocrine-related clinical groups. Significant transitions in the workforce and workplace can be anticipated in the future as a result of Roadmap and Clinical and Translational Science Awards initiatives championed by NIH (38–40), the flattening of the federal budget for research, the passage of health care reform legislation, and the work environment preferences of a new generation of clinically trained endocrinologists. Our findings provide a starting point for initiating a national dialog aimed at the application of improvement tools to enhance the quality of clinical investigation within all workplaces. The present results, moreover, underscore the need to improve the coordination, collaboration, and integration of the nation's investment in clinical research among all partners in the investigative enterprise: federal, institutional, and state (11, 23). Only then will a bright future be assured for medicine and the growing number of patients that suffer from the chronic debilitating effects of endocrine disorders (41).

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