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ORIGINAL RESEARCH

Clinical Exposures During Internal Medicine Acting Internship: Profiling Student and Team Experiences

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BACKGROUND: The clinical learning model in medical education is driven by knowledge acquisition through direct patient-care experiences. Despite the emphasis on experiential learning, the ability of educators to quantify the clinical exposures of learners is limited.

OBJECTIVE: To utilize Veterans Affairs (VA) electronic medical record information through a data warehouse to quantify clinical exposures during an inpatient internal medicine rotation.

METHODS: We queried the VA clinical data warehouse for the patients encountered by each learner completing an acting internship rotation at the Cleveland VA Medical Center from July 2008 to November 2011. We then used discharge summary information to identify team exposures—patients seen by the learner's inpatient team who were not primarily assigned to the learner. Based on the learner and team exposures, we complied lists of past medical problems, medications prescribed, laboratory tests that resulted, radiology evaluated, and primary discharge diagnoses.

RESULTS: Primary learner and team-based clinical exposures were evaluated for a total of 128 acting internship students. The percentage of learners who had a primary exposure to a medication/lab value/imaging result/diagnosis was calculated. The percentage of learners with at least 1 primary or team-based exposure to an item was also calculated. The most common exposures in each category are presented.

CONCLUSIONS: Analysis of the clinical exposures during an inpatient rotation can augment the ability of educators to understand learners' experiences. These types of analyses could provide information to improve learner experience, implement novel curricula, and address educational gaps in clinical rotations. *Journal of Hospital Medicine* 2014;9:436–440. © 2014 Society of Hospital Medicine

The clinical learning model in medical education, specifically in the third and fourth years of medical school and in residency and fellowship training, is driven by direct patient-care experiences and complemented by mentorship and supervision provided by experienced physicians.[1] Despite the emphasis on experiential learning in medical school and graduate training, the ability of educators to quantify the clinical experiences of learners has been limited. Case logs, often self-reported, are frequently required during educational rotations to attempt to measure clinical experience.[2] Logs have been utilized to document diagnoses, demographics, disease severity, procedures, and chief complaints.[3–6] Unfortunately, self-reported logs are vulnerable to delayed updates, misreported data, and unreliable data validation.[7,8] Automated data collection has been shown to be more reliable than self-reported logs.[8,9]

The enhanced data mining methods now available allow educators to appraise learners' exposures during patient-care interactions beyond just the diagnosis or chief complaint (eg, how many electrocardiograms do our learners evaluate during a cardiology rotation, how often do our learners gain experience prescribing a specific class of antibiotics, how many of the patients seen by our learners are diabetic). For example, a learner's interaction with a patient during an inpatient admission for community-acquired pneumonia, at minimum, would include assessing of past medical history, reviewing outpatient medications and allergies, evaluating tests completed (chest x-ray, complete blood count, blood cultures), prescribing antibiotics, and monitoring comorbidities. The lack of knowledge regarding the frequency and context of these exposures is a key gap in our understanding of the clinical experience of inpatient trainees. Additionally, there are no data on clinical exposures specific to team-based inpatient learning. When a rotation is team-based, the educational experience is not limited to the learner's assigned patients, and this arrangement allows for educational exposures from patients who are not the learner's primary assignments through experiences gained during team rounds, cross-coverage assessments, and informal discussions of patient care.

In this study, we quantify the clinical exposures of learners on an acting internship (AI) rotation in

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internal medicine by utilizing the Veterans Affairs (VA) electronic medical records (EMR) as collected through the VA Veterans Integrated Service Network 10 Clinical Data Warehouse (CDW). The AI or subinternship is a medical school clinical rotation typically completed in the fourth year, where the learning experience is expected to mirror a 1-month rotation of a first-year resident.[10] The AI has historically been defined as an experiential curriculum, during which students assume many of the responsibilities and activities that they will manage as graduate medical trainees.[10,11] The exposures of AI learners include primary diagnoses encountered, problem lists evaluated at the time of admission, medications prescribed, laboratory tests ordered, and radiologic imaging evaluated. We additionally explored the exposures of the AI learner's team to assess the experiences available through team-based care.

METHODS

This study was completed at the Louis Stokes Veterans Affairs Medical Center (LSVAMC) in Cleveland, Ohio, which is an academic affiliate of the Case Western Reserve University School of Medicine. The study was approved by the LSVAMC institutional review board.

At the LSVAMC, the AI rotation in internal medicine is a 4-week inpatient rotation for fourth-year medical students, in which the student is assigned to an inpatient medical team consisting of an attending physician, a senior resident, and a combination of first-year residents and acting interns. Compared to a first-year resident, the acting intern is assigned approximately half of the number of admissions. The teams rounds as a group at least once per day. Acting interns are permitted to place orders and write notes in the EMR; all orders require a cosignature by a resident or attending physician to be released.

We identified students who rotated through the LSVAMC for an AI in internal medicine rotation from July 2008 to November 2011 from rotation records. Using the CDW, we queried student names and their rotation dates and analyzed the results using a Structured Query Language Query Analyzer. Each student's patient encounters during the rotation were identified. A patient encounter was defined as a patient for whom the student wrote at least 1 note titled either Medicine Admission Note or Medicine Inpatient Progress Note, on any of the dates during their AI rotation. We then counted the total number of notes written by each student during their rotation. A patient identifier is associated with each note. The number of distinct patient identifiers was also tallied to establish the total number of patients seen during the rotation by the individual student as the primary caregiver.

We associated each patient encounter with an inpatient admission profile that included patient admission and discharge dates, International Classification of Diseases, 9th Revision (ICD-9) diagnosis codes, and admitting specialty. Primary diagnosis codes were queried for each admission and were counted for individual students and in aggregate. We tallied both the individual student and aggregate patient medications prescribed during the dates of admission and ordered to a patient location consistent with an acute medical ward (therefore excluding orders placed if a patient was transferred to an intensive care unit). Similar queries were completed for laboratory and radiological testing.

The VA EMR keeps an active problem list on each patient, and items are associated with an ICD-9 code. To assemble the active problems available for evaluation by the student on the day of a patient's admission, we queried all problem list items added prior to, but not discontinued before, the day of admission. We then tallied the results for every patient seen by each individual student and in aggregate.

To assess the team exposures for each AI student, we queried all discharge summaries cosigned by the student's attending during the dates of the student's rotation. We assumed the student's team members wrote these discharge summaries. After excluding the student's patients, the resultant list represented the team patient exposures for each student. This list was also queried for the number of patients seen, primary diagnoses, medications, problems, labs, and radiology. The number of team admissions counted included all patients who spent at least 1 day on the team while the student was rotating. All other team exposure counts completed included only patients who were both admitted and discharged within the dates of the student's rotation.

RESULTS

An AI rotation is 4 weeks in duration. Students competed a total of 128 rotations from July 30, 2008 through November 21, 2011. We included all rotations during this time period in the analysis. Tables (1–5) report results in 4 categories. The "Student" category tallies the total number of specific exposures (diagnoses, problems, medications, lab values, or radiology tests) for all patients primarily assigned to a student. The "Team" category tallies the total number of exposures for all patients assigned to other members of the student's inpatient team. The "Primary %" category identifies the percentage of students who had at least 1 assigned patient with the evaluated clinical exposure. The "All Patients %" category identifies the percentage of students who had at least 1 student-assigned patient or at least 1 team-assigned patient with the evaluated clinical exposure.

Distinct Patients and Progress Notes

The mean number of progress notes written by a student was 67.2 (standard deviation [SD] 16.3). The

TABLE 1. Most Common Primary Diagnoses

Diagnosis	Student	Team	Primary%	All Patients %
Obstructive chronic bronchitis, with acute exacerbation	102	241	57%	91%
Pneumonia, organism unspecified	91	228	49%	91%
Acute renal failure, unspecified	73	170	46%	83%
Urinary tract infection, site not specified	69	149	43%	87%
Congestive heart failure, unspecified	65	114	41%	68%
Alcohol withdrawal	46	101	26%	61%
Alcoholic cirrhosis of liver	28	98	16%	57%
Cellulitis and abscess of leg, except foot	26	61	18%	45%
Acute pancreatitis	23	51	16%	43%
Intestinal infection due to *Clostridium difficile*	22	30	17%	33%
Malignant neoplasm of bronchus and lung, unspecified	22	38	16%	35%
Acute on chronic diastolic heart failure	22	45	16%	39%
Encounter for antineoplastic chemotherapy	21	96	15%	48%
Dehydration	19	78	13%	46%
Anemia, unspecified	19	36	13%	30%
Pneumonitis due to inhalation of food or vomitus	19	25	13%	24%
Syncope and collapse	16	38	13%	39%
Other pulmonary embolism and infarction	15	41	12%	26%
Unspecified pleural effusion	15	37	10%	34%
Acute respiratory failure	15	42	11%	35%

TABLE 2. Most Common Problem List Items

Problem	Student	Team	Primary%	All Patients %
Hypertension	1,665	3,280	100%	100%
Tobacco use disorder	1,350	2,759	100%	100%
Unknown cause morbidity/mortality	1,154	2,370	100%	100%
Hyperlipidemia	1,036	2,044	99%	100%
Diabetes mellitus 2 without complication	865	1,709	100%	100%
Chronic airway obstruction	600	1,132	100%	100%
Esophageal reflux	583	1,131	99%	100%
Depressive disorder	510	1,005	100%	100%
Dermatophytosis of nail	498	939	98%	100%
Alcohol dependence	441	966	97%	100%
Chronic ischemic heart disease	385	758	95%	100%
Osteoarthritis	383	791	96%	100%
Lumbago	357	692	97%	100%
Current use–anticoagulation	342	629	94%	100%
Anemia	337	674	97%	100%
Inhibited sex excitement	317	610	91%	100%
Congestive heart failure	294	551	91%	100%
Peripheral vascular disease	288	529	88%	99%
Sensorineural hearing loss	280	535	88%	99%
Post-traumatic stress disorder	274	528	91%	100%
Pure hypercholesterolemia	262	521	88%	100%
Coronary atherosclerosis	259	396	87%	95%
Obesity	246	509	89%	99%
Atrial fibrillation	236	469	85%	100%
Gout	216	389	85%	100%

mean number of distinct patients evaluated by a student during a rotation was 18.4 (SD 4.2). The mean number of team admissions per student rotation was 46.7 (SD 9.6) distinct patients.

Primary Diagnoses

A total of 2213 primary diagnoses were documented on patients assigned to students on AI rotations. A

TABLE 3. Most Common Medications Prescribed

Medication	Student	Team	Primary%	All Patients %
Omeprazole	1,372	2,981	99%	100%
Heparin	1,067	2,271	95%	96%
Sodium chloride 0.9%	925	2,036	99%	100%
Aspirin	844	1,782	98%	100%
Potassium chloride	707	1,387	99%	100%
Metoprolol tartrate	693	1,318	98%	100%
Insulin regular	692	1,518	99%	100%
Acetaminophen	669	1,351	98%	100%
Simvastatin	648	1,408	99%	100%
Lisinopril	582	1,309	98%	100%
Furosemide	577	1,186	98%	100%
Docusate sodium	541	1,127	98%	100%
Vancomycin	531	977	98%	100%
Multivitamin	478	1,074	96%	100%
Piperacillin/tazobactam	470	781	98%	100%
Selected examples				
Prednisone	305	613	93%	100%
Insulin glargine	244	492	81%	98%
Spironolactone	167	380	73%	98%
Digoxin	68	125	40%	77%
Meropenem	16	21	11%	24%

TABLE 4. Common Laboratory Tests (Proxy)

Lab Test	Student	Team	Primary%	All Patients %
Fingerstick glucose	12,869	24,946	100%	100%
Renal panel (serum sodium)	7,728	14,504	100%	100%
Complete blood count (blood hematocrit)	7,372	14,188	100%	100%
International normalized ratio	3,725	6,259	100%	100%
Liver function tests (serum SGOT)	1,570	3,180	99%	100%
Urinalysis (urine nitrite)	789	1,537	100%	100%
Arterial blood gas (arterial blood pH)	767	704	78%	99%
Hemoglobin A1C	485	1,177	96%	100%
Fractional excretion of sodium (urine creatinine)	336	677	85%	99%
Lactic acid	195	314	65%	96%
Ferritin	193	413	74%	99%
Thyroid-stimulating hormone	184	391	55%	64%
Lipase	157	317	58%	91%
Hepatitis C antibody	139	327	70%	98%
Haptoglobin	101	208	46%	83%
B-type natriuretic peptide	98	212	48%	87%
Cortisol	70	119	34%	60%
Rapid plasma reagin	70	173	44%	82%
Urine legionella antigen	70	126	38%	64%
D-dimer	59	111	34%	72%
Digoxin	45	69	18%	39%
Paracentesis labs (peritoneal fluid total protein)	34	47	16%	34%
Thoracentesis labs (pleural fluid WBC count)	33	42	20%	38%
C-reactive protein	30	65	17%	34%
Lumbar puncture labs (cerebrospinal fluid WBC count)	22	57	11%	27%
Arthrocentesis (synovial fluid WBC count)	14	23	9%	23%

NOTE: **Abbreviations:**SGOT, serum glutamic oxaloacetic transaminase; WBC, white blood cell.

total of 5323 primary diagnoses were documented on patients assigned to other members of the team during the students' rotations. Therefore, the mean number of primary diagnoses seen by a student during a rotation was 58.9 (17.3 primary diagnoses for

TABLE 5. Most Common Radiology Tests

Radiology Test	Student	Team	Primary%	All Patients %
Chest,2 views,PA and lateral	938	1,955	100%	100%
Chest portable	414	751	96%	100%
CT head without contrast	235	499	82%	100%
CT abdomen with contrast	218	365	59%	71%
CT pelvis with contrast	213	364	59%	70%
CT chest with contrast	163	351	75%	99%
Ultrasound kidney, bilateral	119	208	61%	92%
Abdomen 1 view	107	220	59%	93%
Ultrasound liver	100	183	48%	82%
Modified barium swallow	93	130	53%	82%
PET scan	93	181	49%	79%
Selected examples				
Acute abdomen series	85	177	48%	81%
CT chest, PE protocol	67	126	37%	73%
MRI brain with andwithout contrast	56	109	34%	66%
Chest decubitus	51	76	34%	60%
Portable KUBfor Dobhoff placement	42	62	30%	48%
Ventilation/perfusion lung scan	15	25	12%	27%
Ultrasound thyroid	8	16	5%	17%

NOTE: **Abbreviations:** CT, computed tomography; KUB, kidney, ureter, and bladder; MRI, magnetic resonance imaging; PA, posteroanterior; PE, pulmonary embolism;PET, positron-emission tomography.

student-assigned patients and 41.6 primary diagnoses for team patients). The students and teams encountered similar diagnoses (Table 1).

Problem List

Students and teams evaluated a total of 40,015 and 78,643 past medical problems, respectively. The mean number of problems seen by a student during a rotation was 927 (313 student, 614 team). Table 2 reports the most frequent problems assigned to primary student admissions. Students and teams evaluated similar problems. Hepatitis C (196 student, 410 team) was the only team problem that was in the team top 25 but not in the student top 25.

Medications

A total of 38,149 medications were prescribed to the students' primary patients. A total of 77,738 medications were prescribed to patients assigned to the rest of the team. The mean number of medication exposures for a student during a rotation was 905 (298 student, 607 team). The most frequently prescribed medications were similar between student and the team (Table 3). Team medications that were in the top 25 but not in the student top 25 included: hydralazine (300 student, 629 team), prednisone (305 student, 613 team), and oxycodone/acetaminophen (286 student, 608 team).

Labs

All laboratory tests with reported results were tallied. For common laboratory panels, single lab values (eg, serum hematocrit for a complete blood count) were selected as proxies to count the number of studies completed and evaluated. Table 4 shows a cross-section of laboratory tests evaluated during AI rotations.

Radiology

A total of 6197 radiology tests were completed on patients assigned to students, whereas 11,761 radiology tests were completed on patients assigned to other team members. The mean number of radiology exposures for a student was 140 (48 student, 92 team). The most frequently seen radiology tests were similar between student and the team (Table 5).

DISCUSSION

As medical educators, we assume that the clinical training years allow learners to develop essential skills through their varied clinical experiences. Through exposure to direct patient care, to medical decision-making scenarios, and to senior physician management practices, trainees build the knowledge base for independent practice. To ensure there is sufficient clinical exposure, data on what trainees are encountering may prove beneficial.

In this novel study, we quantified what learners encounter during a 1-month team-based inpatient rotation at a large teaching hospital. We effectively measured a number of aspects of internal medicine inpatient training that have been difficult to quantify in the past. The ability to extract learner-specific data is becoming increasingly available in academic teaching hospitals. For example, VA medical centers have available a daily updated national data warehouse. The other steps necessary for using learner-specific data include an understanding of the local inpatient process—how tests are ordered, what note titles are used by trainees—as well as someone able to build the queries necessary for data extraction. Once built, data extraction should be able to continue as an automated process and used in real time by medical educators.

Our method of data collection has limitations. The orders placed on a learner's primary patients may not have been placed by the learner. For example, orders may have been placed by an overnight resident cross-covering the learner's patients. We assumed that learners evaluated the results of all tests (or medication changes) that occurred at any time during their rotation, including cross-cover periods or days off. In addition, our method for evaluating team exposure underestimates the number of team patients calculated for each learner by limiting the query only to patients whose hospital stay was completed before the student left the inpatient service. It is also difficult to know the how many of the exposures are realized by the learner. Differences in learner attention, contrasts in rounding styles, and varying presentation methods will affect the number of exposures truly attained by the learner. Finally, not all clinical exposures can be evaluated through review of an EMR. Clinical experiences, such as care coordination, patient education, and family counseling, cannot be easily extracted.

Data mining EMRs can enhance clinical medical education. Although our data collection was completed retrospectively, we could easily provide learner-specific data in real time to ward attendings, chief residents, and program directors. This information could direct the development of teaching tools and individualization of curricula. Perhaps, even more importantly, it would also allow educators to define curricular gaps. Whether these gaps are due to the particular patient demographics of a medical center, the practice patterns and strengths of a particular institution, or career interests of a trainee, these gaps may skew the patient-care experiences encountered by individual trainees. We can use these data to identify differences in clinical experience and then develop opportunities for learners—clinical, didactic, or simulated—to address deficiencies and provide well-rounded clinical experiences.

Further investigation to better understand the relationship between direct patient-care experience and clinical skill acquisition is needed. This information could help guide the development of standards on the number of exposures we expect our learners to have with different diagnostic or treatment modalities prior to independent practice. Using learner data to better understand the clinical experiences of our medical trainees, we can hopefully develop more precise and focused curricula to ensure we produce competent graduates.

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