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Human- Versus System-Level Factors and Their Effect on Electronic Work List Variation: Challenging Radiology's Fundamental Attribution Error

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Abstract

Purpose: The aim of this study was to analyze sources of variation influencing the unread volume on an electronic abdominopelvic CT work list and to compare those results with blinded radiologist perception.

Methods: The requirement for institutional review board approval was waived for this HIPAA-compliant quality improvement effort. Data pertaining to an electronic abdominopelvic CT work list were analyzed retrospectively from July 1, 2013, to June 30, 2014, and modeled with respect to the unread case total at 6 PM (Monday through Friday, excluding holidays). Eighteen system-level factors outside individual control (eg, number of workers, workload) and 7 human-level factors within individual control (eg, individual productivity) were studied. Attending radiologist perception was assessed with a blinded anonymous survey (n = 12 of 15 surveys completed).

Results: The mean daily unread total was 24 (range, 3–72). The upper control limit (48 CT studies [3 SDs above the mean]) was exceeded 10 times. Multivariate analysis revealed that the rate of unread CT studies was affected principally by system-level factors, including the number of experienced trainees on service (postgraduate year 5 residents [odds ratio, 0.83; 95% confidence interval, 0.74–0.92; $P = .0008$] and fellows [odds ratio, 0.84; 95% confidence interval, 0.74–0.95; $P = .005$]) and the daily workload ($P = .02$ to $P < .0001$). Individual faculty productivity had a weak effect (Spearman $\rho = 0.13$, $P = .03$; adequacy: 3% of variance explained). The majority (67%) of radiologists (8 of 12) completing the survey believed that variation in faculty effort was the most important influence on the daily unread total.

Conclusions: System-level factors best predict the variation in unread CT examinations, but blinded faculty radiologists believe that it relates most strongly to variable individual effort.

Key Words: Quality, efficiency, culture, workplace

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INTRODUCTION

Digital radiology work lists are common in the era of PACS workstations and radiology information systems (RIS). These lists aggregate imaging examinations and permit radiologists in different locations to make parallel progress on the daily work without redundancy. Work lists lengthen when new examinations are performed and contract when existing examinations are interpreted. Work lists are helpful for collating examinations by date and time, flagging studies with the highest priority (eg, stat), and notifying radiologists in real time of the work that remains to be done.

However, variation in work list length can be a source of stress and frustration [1,2]. As the work list lengthens, it

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creates a visual cue of increasing demand despite the work being performed, which can lead to feelings of hopelessness [1]. Additionally, variation in work list length can affect report turnaround time, which is a performance indicator monitored by many radiology departments as an operational metric and a contributor to patient and referring provider satisfaction [3,4]. Neither an empty nor a massive work list is ideal—an optimal list is one that remains in constant flux with minimal turnaround time and constant demand (ie, a short list with new cases incoming as old cases are outgoing, akin to a lean system). Achieving a streamlined and consistent work list is challenging because many factors both intrinsic and extrinsic can affect it: variable referrer demand, discordance between longer hours over which examinations are performed and shorter hours over which they are interpreted, the day-night cycle, staffing fluctuations, weekends and holidays, degree and type of trainee involvement, attending radiologist work ethic and work pace, and so on. Understanding which factors are the principal drivers of long and variable work lists, and contrasting them with radiologist perceptions, can provide valuable information that could be used to direct targeted quality improvement efforts.

The purpose of our study was to analyze sources of variation influencing the daily weekday unread volume on an electronic abdominopelvic CT work list and to compare those results with blinded radiologist perceptions.

METHODS
Institutional review board approval was waived for this HIPAA-compliant retrospective study. No industry funding was used.

Work List Data
Data pertaining to an electronic abdominopelvic CT work list (inpatient, outpatient, and emergency department studies) at an academic institution from July 1, 2013, to June 30, 2014, were collected by retrospective query of data logs from the department RIS (Centricity; GE Healthcare, Milwaukee, Wisconsin) and voice recognition dictation software (PowerScribe 360; Nuance Communications Inc, Burlington, Massachusetts). Weekends and holidays were excluded because they used different staffing models. Work list details that were extracted included the number of unread examinations on the work list at 6 PM the previous day (if the previous day was a weekday), the number of unread examinations added to the work list between 6 PM the previous day and 8 AM the current day (if the previous day was a weekday), the number of unread

examinations on the work list at 8 AM the current day, the number of examinations added to the work list between 8 AM and 6 PM the current day, the total daily workload (ie, the sum of the examinations on the work list at 8 AM and the number of examinations added from 8 AM to 6 PM the current day), the number of examinations finalized during the current day by faculty radiologists, and the number of unread examinations remaining on the list at 6 PM the current day. Each of these data were subdivided by examination type, as coded in the RIS (stat, urgent clinic visit, routine, outside hospital consultation, or overall), and classified by month (July through June) and day of the week (Monday through Friday).

Examinations were counted by examination, not by Current Procedural Terminology code (eg, each CT angiographic examination of the abdomen and pelvis with lower extremity runoff was counted once). "Unread" was defined as an examination that was present on the work list at the time of interest without a finalized dictation (as indicated by the RIS and dictation software data logs). An audit was conducted of the retrospective data extraction algorithm during a prospective 5-day period to verify its accuracy, and there was 100% concordance between the queried totals and the actual totals.

Faculty and Trainee Staffing Data
The electronic work list under study was managed by faculty radiologists (n = 18) assigned to 1 or more of 6 half-day CT interpretation scheduling designations: primary CT AM (8 AM to 12:30 PM), secondary CT AM (9 AM to 12 PM), primary CT PM (1:30 to 6 PM), secondary CT PM (1:30 to 5 PM), genitourinary (GU) CT AM (8 AM to 12 PM), and GU CT PM (1:30 to 5 PM), for a total of 3 full-time equivalents (FTEs). Individual radiology faculty members were assigned to either half-day CT assignments or full-day CT assignments depending on academic and other obligations. The assignment of AM versus PM shifts was determined at least 1 month in advance and was equitably distributed. In general, all 6 faculty assignments were filled each day. Faculty members on the GU CT rotation (1 of the 3 FTEs) were also responsible for interpreting plain films and conducting GU fluoroscopic procedures (eg, hysterosalpingography, intravenous pyelography, cystography). There was no explicit rule stating that studies performed before a certain time must be finalized before the end of the day. The period of time between 12:30 and 1:30 PM was covered each day by an abdominal radiology fellow, if available. CT examinations interpreted by the fellow during this period were then staffed with an attending radiologist during the afternoon (after 1:30 PM).