A preliminary look at duplicate testing associated with lack of electronic health record interoperability for transferred patients

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ABSTRACT

Duplication of medical testing results in a financial burden to the healthcare system. Authors undertook a retrospective review of duplicate testing on patients receiving coordinated care across two institutions, each with its own electronic medical record system. In order to determine whether duplicate testing occurred and if such testing was clinically indicated, authors analyzed records of 85 patients transferred from one site to the other between January 1, 2006 and December 31, 2007. Duplication of testing (repeat within 12 hours) was found in 32% of the cases examined; 20% of cases had at least one duplicate test not clinically indicated. While previous studies document that inaccessibility of paper records leads to duplicate testing when patients are transferred between care facilities, the current study suggests that incomplete electronic record transfer among incompatible electronic medical record systems can also lead to potentially costly duplicate testing behaviors. The authors believe that interoperable systems with integrated decision support could assist in minimizing duplication of testing at time of patient transfers.

INTRODUCTION AND BACKGROUND

Previous studies support the potentially beneficial impact of electronic health record implementation.[1–3] Wang and colleagues estimated that utilization of electronic health records can result in a net benefit of $86 400 per provider over 5 years through benefits accruing from savings in drug expenditures, improved utilization of testing, and improved billing practice. Wang and colleagues estimated averages in testing reductions (8.8% laboratory and 14% radiology) that will result from the implementation of decision support within the electronic health record.[4] Tierney and researchers from the Regenstrief Institute for Healthcare in Indiana found that providers decreased test ordering when presented with results along with the time interval between first and last tests.[3] Furthermore, a Rand study determined that duplication in personnel efforts can occur owing to lack of integrated health information technology.[5] The Rand study estimated that approximately 63% of outpatient paper chart pulls in an institution were duplicate efforts and could be eliminated with the implementation of integrated health information technology. Tierney *et al* demonstrated that care provider order entry with decision support can limit outpatient duplicate testing.[6] Published studies by Walker, van Walraven, Balas, and other groups have explored the benefits of compatible electronic record system implementations, including a reduction in duplication through the implementation of fully integrated and interoperable electronic health records rather than a stand-alone electronic health record.[7–9]

This study examines an adult congenital heart disease (ACHD) patient population in Boston, Massachusetts. Children's Hospital Boston (CHB) and the adult-patient-oriented Brigham and Women's Hospital (BWH)—connected via a bridge between buildings—developed a shared model to provide care for ACHD patients at whichever site is most medically appropriate for the patient at a given point in time. Each institution maintains a separate electronic health record system. Given the distributed expertise at these institutions, hospital-bound patients are often treated on an outpatient basis at CHB and then admitted to BWH. Unlike care for acquired heart disease in adult patients (>21 years old), patients with congenital heart disease often receive care from physicians specializing in congenital heart disease, who are responsible for both outpatient and inpatient care at both pediatric and adult hospitals. These physicians have clinical skills to manage patients with complex cardiac anatomies and complicated medical histories. The setting of shared care among two physically connected institutions in Boston afforded the authors an opportunity to study whether duplication in laboratory and ancillary testing occurred between the pediatric and adult institutions. A key motivator for this analysis was that the institutions at the time of the study did not share an interoperable electronic health record system. Based on previous studies, the authors used current study results to estimate potential costs of duplicate testing that was not clinically indicated.

METHOD

The authors conducted a descriptive, retrospective pilot study to examine clinically non-indicated inter-hospital duplication of blood laboratory and ancillary testing for patients whose care was transferred between CHB and BWH. The target population was ACHD patients admitted between January 1, 2006 and December 31, 2007, by the Boston Adult Congenital Heart service, (BACH), to BWH after clinic visit, catheterization or emergency room visit to a pediatric hospital, CHB, earlier the same day. The study identified patients by cross-referencing a clinical practice database used to track admissions with the registration, billing, and appointment database, EPIC (Epic

Systems Corporation, Madison, WI, USA) at CHB. Before research was started, scientific review committee approval was obtained at CHB and institutional review board (IRB) approval at both CHB and BWH was obtained.

Electronic health record databases at both institutions—Cerner Powerchart (Cerner Corporation, Kansas City, MI, USA) and Partners' self-developed Longitudinal Medical Record (LMR)—were examined to identify all blood testing, radiography, ECG, and echocardiograms obtained within the first 12 hours of hospitalization. Testing was considered duplicative if it was performed at CHB and repeated at BWH within 12 hours of admission to BWH. Any repeated testing conducted outside of the 12 hours between the outpatient visit and post-admission was excluded from the current study. While potentially another source of duplicate testing, pre-catheterization testing results were systematically excluded from the current study as such testing was typically performed outside the 12-hour window defined by this study. To accurately represent physician practices and test prices, as well as to overcome inter-hospital variance in blood panel designation, each individual test within a laboratory panel was assessed for duplication between institutions.

Two cardiologists blinded to patient name and demographics each reviewed all instances of duplicate testing identified, and placed them into the context of clinical course by reviewing de-identified records, so as to categorize each duplicate test as clinically indicated or not. The cardiologists were instructed to consider duplicate tests as 'not indicated' if they determined that the tested patient was clinically stable at the time of duplicate test ordering, and that the duplicate test would not have been required by the routine standard of care, had the initial testing result been available or known to the ordering clinician. Otherwise, the duplicate test was deemed to be 'clinically indicated.' A third cardiologist resolved any disagreements between categorizations by the first two reviewers.

The study excluded BWH admissions from CHB sites that did not refer at least five patients for admission during the study period. This was done to minimize random errors arising from unusual situations.

The authors then assigned 'costs' to identified duplicate testing using a standard 2008 Medicare fee[10] schedule, in order to estimate the magnitude of professional and technical expenditures attributable to duplications in testing.

RESULTS

A total of 833 ACHD patients were hospitalized under the guidance of the BACH service during the 2-year study time period. The study examined each of these 833 admissions to identify only those who were admitted to BWH immediately after a prior catheterization or outpatient visit at CHB. Of such patients, 85 were seen at CHB prior to the BWH admission and received testing during the first 12 hours (table 1) of admission to BWH. The 85 patient records were analyzed for duplicative testing. Duplicate testing occurred in 27/85 (32%) patients and was categorized as 'not clinically indicated' in 17/85 (20%) patients (table 2). Fifty percent of the patients with duplicative testing had more than one test duplicated. Table 3 shows testing rates and duplicate testing rates for the 85 patients.

In this study, the emergency room as a source of admission occurred only once, and was not considered for further independent statistical comparison to minimize random error. The differences in non-clinically indicated duplication between the other two admission sources are listed (table 4).

Table 1 Total testing by hospital site during 12-hour review (n=85 patients)

	Hospital site		
Testing performed	Children's Hospital Boston	Brigham and Women's Hospital	Number of duplicates identified
Echocardiogram	32	4	1
EKG	34	39	15
Chest x-ray	13	27	4
Lung scan	0	1	0
Cardiac MRI	3	0	0
Coronary CT angiogram	1	0	0
Other testing	ICD check	Ultrasound, CT pelvis	0
Blood sample panels	111	157	14

The estimated total cost of test duplication in the 12-hour period defined by this study was $1255 for the entire patient population (for the 17 of the 85 patients encountered who had non-clinically indicated duplication). Ninety percent of the estimated unnecessary costs ($1134/$1255) occurred in patients who were admitted after an outpatient visit (table 4).

DISCUSSION

This study presents an exploratory analysis of duplicate testing performed within a narrowly defined window of time in a unique patient population receiving care across two physically neighboring institutions. The purpose of the study was to document the potential extent of duplicate testing and estimate related costs related to early phase in-hospital care of patients recently seen at another institution, which were associated with a lack of electronic health record interoperability. This sort of problem will become increasingly common as healthcare institutions adopt diverse vendors' electronic medical record systems. The extent of clinically non-indicated duplicate testing documented in the study is of some concern. It related to transfer of patient care between two physically connected institutions, both with electronic health records systems, and in which direct clinician to clinician communication is facilitated. The potential for such duplications may be even greater in other circumstances that involve more complexity in information transfer. These include, for example, (a) admission to a hospital from a non-hospital-based clinician outpatient practice not affiliated with the hospital, or between two different non-affiliated hospitals, and (b) periodic change in healthcare providers, as typified by the estimated 800 000 or more seasonal migrants, many of whom are older and have established healthcare needs, from the northeast USA to the state of Florida.[11]

Study limitations narrow the potential applicability of results outside of the two hospitals studied; rather, current study

Table 2 Duplicate testing by admission source

Source of hospital admission	Total number of admissions	Number of subjects with duplication	Number of subjects with clinically indicated duplication (% of total)	Number of subjects with non-clinically indicated duplication (% of total)
Catheterization laboratory	56	9	8 (89%)	1 (11%)
Outpatient visit	29	18	2 (11%)	16 (89%)
Total	85	27	10 (37%)	17 (63%)

Table 3 Testing frequency and duplication rates for 85 patients

Testing	Total tests ordered	Ordered frequency per patient	Total testing duplication*	% Of total testing ordered	Non-clinically indicated testing*	% Of total testing ordered
Echocardiogram	**36**	41%	1	3%	0	0%
EKG	**73**	50%	15	21%	15	21%
Chest x-ray	**40**	37%	4	10%	4	10%
Lung scan	**1**	1%	0	0%	0	0%
Cardiac MRI	**3**	3%	0	0%	0	0%
Coronary CT angiogram	1	1%	0	0%	0	0%
Other testing						
Blood sample panels	**268**	93%	13	16%	6	8%

*Blood sample panels broken into individual components.

results should stimulate further research. The study examined a highly specific patient population that is not necessarily representative of all patients receiving care. Further limitations include the strict requirement for a 'duplicated' test to occur in a medically stable tested patient and ordering behavior to be deemed 'outside the standard of practice,' for testing to be considered clinically 'not-indicated'; as such, this analysis is likely an underestimate of excesses in routine practice. Medicare fees, or actual payments that would be made by Medicare for respective testing, were used to estimate costs to the healthcare system rather than actual hospital and physician charges, which are generally higher and often vary by hospital and physician. The current study addressed neither the socioeconomic influences on nor determinants of duplicate clinical testing, nor the physical or emotional impact of unnecessary testing on patients and their families.

The most common setting for duplicate testing identified in the current study happened on admission from an outpatient clinic site. Patients from outpatient clinic transfer to hospital admission via several paths, including entrance via hospital admitting services or directly to the inpatient ward, either escorted or unescorted by hospital clinical staff. While clinician to clinician passage of data regarding medical testing and status is recommended to occur in a timely fashion in such circumstances, this does not reliably occur. The authors believe that an interoperable health record conveying shared data with prior test results notification, alerts, and/or decision support could potentially improve the immediate availability of medical history and clinical status data, including testing results, between the various outpatient referral sources and the admitting institution. In addition, an interoperable electronic health record would make available expensive imaging studies, further reducing the need for potential duplicate studies. Based on estimates from current study results, implementation of an interoperable electronic health record system between the two study institutions would potentially result in at least modest savings in the narrow domain studied, and potentially larger overall savings. Other disease categories and patient populations where patients are treated across institutions could potentially reap a larger benefit from eliminating non-clinically indicated duplicative testing via integrated record systems with decision support. For example, a study of 104 trauma patients transferred between facilities in Massachusetts documented charges of $639 per patient related to duplicate testing.[12]

Prior studies by Tierney and colleagues show that the provision of increased information pushed to providers regarding prior testing results at the time of ordering leads to a reduction in ordering.[3] The current study and others[12] show that transfer of records containing important clinical data is imperfect when patients are transferred from one healthcare institution to another, resulting in duplicate testing—even when both institutions have electronic record systems. An opportunity exists to improve timeliness of care and decrease through implementation of interoperable electronic health records (EHRs) between institutions. Current efforts to do so via healthcare information exchanges (HIEs) at local, regional, and national levels are under way.[13–15] Recent Federal actions to define 'meaningful use' of electronic health records[16] and to establish criteria for certification of EHR products[17] through regulation are likely to further encourage electronic transfer of clinical data.

An expansion of this study to include additional patient populations, additional institutions, and a wider timeframe between services provided at the institutions will provide additional data about duplication and how widely this study can be extrapolated. Studying inter-hospital transfer between health systems with interoperable medical records and decision support would provide further insights. Future research may also explore duplication prior to the implementation of electronic health records at both institutions to determine whether this phenomenon existed when paper medical records were utilized between institutions.

Despite efforts to minimize non-clinically indicated duplicate testing between institutions without interoperable electronic health records, duplication exists. Results from this study show

Table 4 Occurrence of duplication by source of admission and corresponding estimated cost

Source of admission	Total admissions	Not clinically indicated (% duplicated)	% Not clinically indicated	No duplication	Estimated total cost*	Estimated duplication cost per patient†
Catheterization laboratory	56	1 (2%)	11%	55	$121	$2.17
Outpatient visit	29	16 (55%)	89%	13	$1134	$39.10
Totals	85	17 (20%)	63%	68	$1255	$14.77

*Based on 2008 Medicare fee schedule.
†Cost in dollars/total patients admitted via specific source of admission.

that approximately 20% of the patients in the study encountered non-clinically indicated duplicate testing resulting in added costs to the healthcare system.

Competing interests None.

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