



Review

Factors associated with imaging overuse in the emergency department: A systematic review[☆]



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ABSTRACT

Background: Emergency departments (ED) are sites of prevalent imaging overuse; however, determinants that drive imaging in this setting are not well-characterized. We systematically reviewed the literature to summarize the determinants of imaging overuse in the ED.

Methods: We searched MEDLINE® and Embase® from January 1998 to March 2017. Studies were included if they were written in English, contained original data, pertained to a U.S. population, and identified a determinant associated with overuse of imaging in the ED.

Results: Twenty relevant studies were included. Fourteen evaluated computerized tomography (CT) scanning in patients presenting to a regional ED who were then transferred to a level 1 trauma center; incomplete transfer of data and poor image quality were the most frequently described reasons for repeat scanning. Unnecessary pre-transfer scanning or repeated scanning after transfer, in multiple studies, was highest among older patients, those with higher Injury Severity Scores (ISS) and those being transferred further. Six studies explored determinants of overused imaging in the ED in varied conditions, with overuse greater in older patients and those having more comorbid diseases. Defensive imaging reportedly influenced physician behavior. Less integration of services across the health system also predisposed to overuse of imaging.

Conclusions: The literature is heterogeneous with surprisingly few studies of determinants of imaging in minor head injury or of spine imaging. Older patient age and higher ISS were the most consistently associated with ED imaging overuse. This review highlights the need for precise definitions of overuse of imaging in the ED.

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Healthcare expenditures in the United States remain exceptionally high, without consistent health benefits [1,2]. The disparity between costs and outcomes of care has received much attention [3] and suggests that healthcare services are overused in the US [4]. Within the emergency department (ED), radiologic imaging is recognized as a healthcare service that is overused. Indeed, use of imaging in the ED has increased disproportionate to the number of visits in recent decades. Kocher and colleagues reported that ED visits increased nationwide by 30% from 1996 to 2007 while computed tomography scanning (CT) rose 330% [5]. Data from the National Hospital Ambulatory Medical Care Survey further

support this trend; use of CT or magnetic resonance imaging (MRI) tripling and use of ultrasound doubled between 2001 and 2010 [6].

Reduction of unnecessary imaging in the ED has been an area of significant focus recently. In 2013 and 2014, as partners in the Choosing Wisely campaign led by the American Board of Internal Medicine (ABIM) Foundation, the American College of Emergency Physicians (ACEP) released guidelines that cautioned against low-yield imaging for a number of clinical conditions [7]. In 2015, the Society for Academic Emergency Medicine (SAEM) held a consensus conference focused on a research agenda to optimize diagnostic imaging in the ED [8].

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While there is growing appreciation that overuse of services is prevalent in our healthcare system including in the ED, the determinants of overuse are poorly characterized [9]. In this systematic review, we focus specifically on summarizing determinants of imaging overuse in the ED. We aimed to systematically synthesize the primary literature describing factors that are positively or negatively associated with overuse of imaging in this setting.

1. Methods

For this review, overuse was operationally defined in accordance with the definition used by the Agency for Healthcare Research and Quality as “the provision of health care services where the likelihood of harm exceeds the likelihood of benefit.” [10] Because the term *overuse* was seldom employed by the original study authors, we needed to deduce whether imaging overuse was being described. We determined by consensus that studies describing duplicate imaging, imaging in contradiction to established guidelines, and imaging that was determined by the authors of the included studies to be unnecessary or inappropriate with valid justification (see Table 1) were relevant to this review.

1.1. Data sources and searches

We began with a scoping review by searching MEDLINE® and Embase® from January 1998 through July 2016. Our initial search broadly included terms reflecting use and overuse of healthcare services, including procedures and diagnostic tests. We searched using the medical subject heading terms and keywords related to the overuse of healthcare services: “medical overuse” OR “health services misuse” OR health services overutilization OR “unnecessary procedures” OR medically unnecessary procedures OR Diagnostic Tests, Routine/utilization OR Defensive Medicine OR Practice Patterns OR Health Services Abuse OR Health Services Overuse OR medical overutilization OR inappropriate utilization. We followed with a targeted search through March 1, 2017 with specific terms for articles addressing overuse of imaging in the ED: “diagnostic imaging” OR radiography OR tomography OR scanning OR scans OR scan OR imaging OR “magnetic resonance” OR “diagnostic testing” OR “diagnostic evaluation.” We hand searched the reference lists of each included article as well as related systematic reviews for additional articles. Searches were limited to human studies in the English language. Our protocol followed PRISMA guidelines and was registered in Prospero (#CRD42015029482) as part of a broader review examining overuse of several types of healthcare services.

1.2. Study selection

Two reviewers independently screened titles, abstracts, and full-text for inclusion. Differences between reviewers were resolved through consensus adjudication. Studies were included if they were written in English, contained original data, pertained to a U.S. population, and identified a determinant associated with overuse of imaging in this setting. Studies describing only the prevalence of overuse, and not its determinants, were excluded. We further restricted the study to data collected after 1996, given the substantial changes in the U.S. healthcare system in the past two decades regarding availability of imaging technologies. We had no restrictions regarding study design.

1.3. Data extraction, quality, and applicability assessment

Using standardized forms, reviewers extracted information on the general study characteristics, study participant characteristics, the methods of data collection, the overuse event under investigation, the determinants evaluated by the investigators and the determinants identified as being significantly associated with the overuse event. The determinants were classified as being related to the patient, the clinician, or the environment including the region and health system. A second reviewer confirmed the accuracy of the abstracted data. We used the criteria for determining statistical significance as had been defined by each article. For studies that

analyzed significance with both bivariate and multivariate methods, we extracted only the significant results from the multivariate analyses.

Two reviewers independently assessed the risk of bias in included articles using previously validated instruments. The Critical Appraisal Checklist (from the Center for Evidence Based Management) was used for cohort studies and surveys [11]. The single qualitative study was assessed using the Checklist for Qualitative Research from the Joanna Briggs Institute [12].

1.4. Data synthesis and analysis

We created detailed evidence tables. We synthesized the results by the type of imaging and then by the determinants, organized as patient-level, clinician-level, and organizational or environmental. We created summary tables of these results. The results were not amenable to quantitative pooling given the heterogeneity in design across studies.

1.5. Role of the funding source

The funders had no role in this project.

2. Results

We identified 10,859 titles meeting our inclusion criteria. Of these, 484 articles proceeded to full-text review (Appendix Fig. 1). We identified 20 studies meeting our inclusion criteria that examined determinants of overuse of imaging in EDs.

2.1. Characteristics of included studies

The included studies were five retrospective cohort studies [13–17], two cross-sectional studies [18,19], six surveys [20–25], four prospective cohort studies [26–29], two studies having both retrospective and prospective cohort components [30,31], and one qualitative study [32].

Determinants were evaluated for their independent contribution to overuse with multivariate regression methods in seven of the studies [15–17, 27–30]. Five studies reported only bivariate analyses [13,14,18,25,26], and seven were entirely descriptive in their presentation of results [19–24,31].

Because the majority of identified studies focused on duplicate imaging in transferred trauma patients, we present the results as: 1) determinants of duplicate imaging in patients with trauma transferred to a trauma center, and 2) determinants of unnecessary, inappropriate or defensive imaging in the ED among diverse patients who were not transferred.

2.2. Risk of bias

This body of literature was not of high quality. The risk of bias was determined to be moderate in 13 studies [13–16,18,20,21,23–25,27,28, 30] and high in four studies [19,22,26,31]. Only two studies [17,29] were considered to have a low risk of bias. Prominent flaws included the lack of reporting of response rates in surveys and the lack of use of validated tools for data collection. Most of the studies did not clearly describe the characteristics of the study participants at enrollment. The quality of the single qualitative study was good [32].

2.3. Determinants of duplicated scans in transferred patients with trauma

Twelve studies described scans duplicated in patients arriving at a level 1 trauma center after transfer [13–16,19,22–24,26,28,29,31]. Two studies described acquisition of scans at the referring facility prior to emergent transfer [17,25].

Eight out of 12 studies of duplicate scans upon arrival probed the reasons for ordering the duplicated scan; this was learned either by survey [22], by medical record review [13,19,26,29,31] or by medical record review with adjunctive physician report [23,24] (Table 2). Two reasons were noted in all eight studies: 1) the scan was not received by the trauma center or there was inadequate transfer of data; and 2) the quality of the transferred

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