THE INCENTIVES AND EFFECTS OF UNNECESSARY EMERGENCY AMBULANCE TRANSPORT

by

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ABSTRACT

JACKSON DAVID DEZIEL. The incentives and effects of unnecessary emergency ambulance transport. (Under the direction of DR. JENNIFER TROYER)

In the EMS field, the problem of low-acuity, non-emergency individuals who summon an emergency ambulance for simple transport to a local hospital is ever-present. Any person may summon an emergency ambulance and receive transport for the most minor of injury or illness. The consequences of ambulance misuse are many, including emergency resource depletion, increased public cost, and emergency department over-crowding. The Institute of Medicine has outlined these concerns in its most recent report on EMS (IOM, 2006) yet little institutional change has occurred.

This dissertation seeks to identify possible incentives and effects of unnecessary emergency ambulance transport. Findings suggest that patient transport to the emergency department via ambulance is influenced by EMS ownership status due to differences in operational funding. Privately owned EMS agencies were found to be much more likely to engage in patient transport than publicly owned agencies. Furthermore, upon arrival to the emergency department, physicians are more likely to provide diagnostic services to ambulance patients. This "ambulance signal" acts through implication that an ambulance patient is more acute simply due to the mode of arrival. The presence of an ambulance signal is evidenced by the inverse relationship between the likelihood of receiving diagnostic services and the ambulance patient's medical acuity level. Demographic signals (such as age, gender, race, ethnicity, and poverty) are also investigated as enhancers or mediators of the ambulance signal.

ACKNOWLEDGEMENTS

Though this dissertation is deemed an individual work, I could not have reached this point without the assistance of several people. First, the guidance, support, and constructive feedback from Dr. Jennifer Troyer have been invaluable. With an incredible ability to provide productive and detailed comments, this work could not have progressed without her. Second, I am enormously grateful to my committee members Dr. Shelley Listwan, Dr. Teresa Scheid, and Dr. Cem Saydam for their depth of knowledge in multiple disciplines and their valuable feedback. Their advice and encouragement has only strengthened my own research path. Third, I would be remiss to ignore the support of my peers. Brian Jones, Chuck McShane, Hollie Tripp, Jennifer Wienke, Meika Garner, Melisa Stivaletti, and Sam Grubbs have spent countless hours watching my presentations, reading my work, and supporting my overall educational and psychological well-being. I certainly would not have reached this point without them.

DEDICATION

This dissertation is dedicated to a number of people, each of which has pushed me further than I ever thought I could go. My wife, Marissa. My son, Luc. My parents, David and Janice. My brother, Ryan. Each has provided me with the inspiration and unwavering support to continue on this path. I would also like to dedicate this dissertation to Dr. Denise Wilfong, and Mr. Jeffery Roberts. Dr. Wilfong not only taught me how to be a paramedic, but also encouraged my educational path and provided me with mentorship and friendship over the years. Additionally, Jeffery Roberts taught me *to be* a paramedic. Jeff's mentorship ten years ago shaped me as a medical provider and his influence has continued to this day.

INTRODUCTION

In 1966, the National Academy of Sciences published the landmark report *Accidental Death and Disability: The Neglected Disease of Modern Society.* This report subsequently set into motion the development of the modern American emergency medical services (EMS) system. As we approach the fiftieth anniversary of this national commentary, the robust EMS system to which we have grown accustomed has seen an ever-increasing trend of improper utilization from a subset of non-emergency patients.

Unnecessary ambulance transport is broadly defined and can be applied when a patient may travel to the hospital by other means without the threat of medical deterioration. Dependent on the conceptual definition, researchers have noted that 11% to 61% of all ambulance transports to the emergency department (ED) are medically unnecessary (Weaver, et al., 2012). Employing a governmental definition of medical necessity, the Centers for Medicare and Medicaid Services (CMS) has estimated that approximately 13% of Medicare patients transported by ambulance were well enough to travel by other means (OIG, 2006). Furthermore, Weaver, et al. (2012) notes that the proportion of unnecessary ambulance utilization is increasing year by year.

In the EMS field, the problem of low-acuity, non-emergency individuals who summon an emergency ambulance for simple transport to a local hospital is ever-present. Due to current legal statutes and concerns relating to liability, an emergency ambulance crew cannot deny transport to a patient who requests it. Thus, any person may summon an emergency ambulance and receive transport for the most minor of injury or illness. The consequences of ambulance misuse are many, including emergency resource depletion, increased public cost, and emergency department over-crowding. The Institute of Medicine has outlined these concerns in its most recent report on EMS (IOM, 2006) yet little institutional change has occurred.

While we have identified the problem of unnecessary transport, existing academic literature has yet to determine why this issue remains problematic. This dissertation will shed light onto the issue of emergency ambulance misuse by applying the theoretical concepts of bureaucratic budget maximization (Niskanen, 1971), non-profit quality maximization (Newhouse, 1970), for-profit profit maximization (Smith, 1776), and economic signaling (Spence, 1973) to ambulance and emergency department data. The following chapters will explore issues pertaining to unnecessary emergency ambulance transport and highlight the perverse incentives that may be contributing to emergency ambulance misuse.

First, I analyze ambulance transport as a function of agency ownership status. Patient transport generates the greatest amount of revenue for an EMS organization and is typically the only service that will be reimbursed by insurers. With their relatively stable public budgets, publicly funded EMS organizations may enjoy more freedom to engage in activities that do not directly generate revenue. Privately funded organizations, however, may have to rely heavily on user fees and revenue generated from billable expenses to remain operational. Thus, private EMS agencies are thought to be much more likely to transport a given patient, as compared to their publicly funded counterparts.

Second, I examine the effects of ambulance transport on diagnostic testing in the emergency department. Due to the imperfect balance of information between the physician and the patient upon initial arrival, the application of Spence's (1973) work on signaling theory leads to the idea that patients are utilizing ambulance transport as an information conveyance mechanism. Ambulance patients are hypothesized to be more likely than otherwise similar non-ambulance patients to receive diagnostic testing in the emergency department.

Third, I explore the moderating effects of age, gender, race, ethnicity, and poverty on the power of the ambulance transport signal as it pertains to diagnostic testing in the emergency department. I examine the effects of the adjustable signal of ambulance transport on diagnostic provision in the ED and how non-adjustable characteristics such as age, gender, race, ethnicity, and poverty may mediate or enhance the ambulance signal. Each unalterable trait is expected to affect the power of the ambulance transport signal as it relates to the provision of diagnostic testing in the ED. Thus, certain subsets of ambulance patients may be deriving more value from the ambulance signal.

Following the publication of the National Academy of Sciences' *Accidental Death and Disability: The Neglected Disease of Modern Society,* the American EMS system has continually evolved and grown in a positive direction. However, the issue of medically unnecessary ambulance transport has been a persistent problem for decades. Despite attention from the Institute of Medicine, the cause of ambulance misuse has not been fully explored. By identifying the incentives of unnecessary ambulance transport, this dissertation will begin to pinpoint the causal basis for ambulance misuse.

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THE EFFECTS OF EMS AGENCY OWNERSHIP STATUS ON PATIENT TRANSPORT

Medical insurers have clearly defined which EMS services will be reimbursed. In short, patient transport generates the greatest amount of revenue for an EMS organization and is typically the only service that will be reimbursed by insurers. With their relatively stable public budgets, publicly funded EMS organizations may enjoy more freedom to engage in activities that do not directly generate revenue. Privately funded organizations, however, may have to rely heavily on user fees and revenue generated from billable expenses to remain operational. Thus, private EMS agencies are thought to be much more likely to transport a given patient, as compared to their publicly funded counterparts.

The decision whether to contract public services is one that faces virtually every local municipality. While the reasons are varied, arguments over privatization of municipal services can be reduced to concerns with cost-control and efficiency. On the local level, however, privatization does not appear to achieve these goals (Johnson, et al., 2004). Subsequently, when a locality elects to externalize a public service there are many considerations that must be weighed. One of these concerns is what the EMS firm is attempting to maximize. Each organization has its own operational motivations and may seek to maximize profit, quality, or budget size.

Economic theory provides a solid foundation for considering what these agencies are maximizing and a point from which to analyze maximization differences among governmental, non-profit, and for-profit emergency ambulance services. First, Adam Smith (1776) and the school of neoclassical economics portray the for-profit firm as a *profit* maximizer. The private for-profit firm exists precisely to generate profit for its shareholders and will seek to maximize the difference between revenue and cost. Second, Joseph Newhouse (1970) has set forth a theory of the non-profit hospital as a *quality* maximizer. While revenue remains an important feature for the non-profit organization, it is not essential beyond covering operational costs. As a health care organization, I extend this theory to EMS organizational function. The primary mission of both hospital and EMS organizations centers on patient care. Thus, the direct delivery of medical care makes these two institutions relatively comparable. Third, William Niskanen's (1971) view of the *budget*-maximizing bureaucratic agent is applied to public EMS organizations. Without direct revenue in exchange for services, governmental agencies fund operations through the public budgeting process. The larger one's budget, the greater the opportunity for bureaucratic power and relevance.

The opportunity for EMS contracts across the United States is abundant, but not all jurisdictions respond in the same manner. The non-profit Rockingham Regional Ambulance (RRA) was New Hampshire's largest and oldest EMS provider. On September 30, 2011, however, RRA ceased operations. This ambulance service did not end its operations due to customer complaints, financial difficulties, or regulatory mandates. Instead, RRA lost its municipal EMS contracts to American Medical Response (AMR), who won the local bidding process by out-bidding by $80,000 per year.

Further west, in Alameda County (California), AMR was forced to cease operations. Just as the largest for-profit ambulance company was taking over EMS operations in southern New Hampshire, the company was simultaneously evicted from this central California county. Alameda County chose instead to contract with Paramedics Plus, who out-bid AMR by a whopping $172.4 million per year. Recently, AMR and

Paramedics Plus have come face-to-face across the nation, often with the latter being the victor. AMR expected to collect approximately $84 million from the Alameda County contract (Ellison, 2011).

Paramedics Plus, one of the more recent players in the for-profit EMS has successfully secured contracts in Texas, California, Indiana, and Florida. As Ellison (2011) succinctly put it, “competition for ambulance contracts is fierce…” But the effects of municipal privatization in this area have remained relatively untouched by researchers. The incentives of each type of service (governmental, non-profit, for-profit) deserve a level of scrutiny.

Just as AMR was winning and losing municipal EMS contracts, Kansas City (Missouri) made the decision to terminate all EMS contracting activity. Beginning operations in 1979, Metropolitan Ambulance Services Trust (MAST) served as an oversight organization, tasked with contracting a private entity (in this case, Emergency Providers, Inc.) to provide emergency ambulance services for the city. Citing issues over quality and efficiency, Kansas City chose to dissolve MAST and instead internalize EMS operations in 2011. The city council chose to delegate EMS functions to the city’s fire department, reallocating approximately 60 ambulances and nearly $30 million.

Constrained by health insurance reimbursement policy and practices, organizational ownership may be an important, yet overlooked variable when analyzing organizational outcomes. Private EMS agencies may seek to increase revenue through increased patient transport. Public EMS organizations, however, may instead pursue a larger budget by proving relevance through call volume irrespective of patient transport.

LITERATURE REVIEW

Ambulance Reimbursement Policy

The Medicare fee-for-service method of payment is likely to remain the standard for ambulance reimbursement (Ginsburg, 2012). Thus its structure, copied by private insurance companies as well, deserves some level of explanation. The current ambulance fee schedule was introduced in 1997 through Section 1834(1) of the Social Security Act, added by Section 4531(b)(2) of the Balanced Budget Act of 1997. Through this fee schedule, Medicare payment will cover only patient transport to the nearest appropriate medical facility if other transportation might worsen one's health condition.

Medicare reimbursement is based on four general transport categories: Basic Life Support (BLS), Advanced Life Support (ALS), Specialty Care Transport (SCT), and Paramedic Intercept[1] (PI). Transport categories are further broken down and assigned Relative Value Units (RVU) as follows in Table 1 (CMS, 2014). Table 1 continues to describe each service category and its requirements for reimbursement at that level.

TABLE 1: Ambulance transport service level with description

Transport Service Level	RVU	Description
BLS	1.00	Transportation by ambulance and included necessary supplies/services. Level of care provided by EMT-Basic
BLS – Emergency	1.60	Transportation by ambulance and included necessary supplies/services within the context of an emergency response to the patient. Level of care provided by EMT-Basic
ALS1	1.20	Transportation by ambulance and included necessary supplies/services. Includes the provision of an ALS assessment or at least one ALS intervention provided by a paramedic.
ALS1 –	1.90	Transportation by ambulance and included necessary

[1] Paramedic Intercept (PI) services are provided by an organization that does not provide ambulance transport. PI services are covered by Medicare only in rural areas in which a PI service is contracted with an ambulance transport supplier that operates at the BLS level.

Emergency		supplies/services within the context of an emergency response to the patient. Includes the provision of an ALS assessment or at least one ALS intervention provided by a paramedic.
ALS2	2.75	Transportation by ambulance and included necessary supplies/services. Includes at least three separate medication administrations or the provision of at least one invasive medical procedure, provided by a paramedic.
SCT	3.25	Interfacility transportation by ambulance and included necessary supplies/services. Services furnished above and beyond the scope of the normal paramedic.
PI	1.75	ALS services, delivered by a paramedic responding in a non-transporting unit, which is provided separately from the transporting agency.

In a 1999 report compiled by the Office of Inspector General and its Office of Evaluation and Inspections, Medicare's ambulance reimbursement system was compared to policies of other public and private health insurance payers. The Medicare structure was evaluated against four state Medicaid programs, ten private commercial health plans, and two federal military health care programs. The report concluded that the fee-for-service reimbursement method predominated among all payers and that transport payment was based upon service level (e.g.: BLS, ALS, SCT) similar to the Medicare system (OIG, 1999). Although private payers negotiated payment rates in different ways, transport remained the only reimbursable service.

Retrospective study has found that approximately 16% of Medicare-covered 9-1-1 ambulance patients were non-emergency and/or could be effectively treated in a primary care setting (Alpert, et al., 2013). Furthermore, of those patients who were subsequently discharged from the ED, 34% of patients were discharged with a low-acuity diagnosis that could have been treated in a non-emergency setting (Alpert, et al., 2013). Alpert, et al. (2013) conclude that if Medicare reimbursement policy were to accommodate alternative modes of EMS treatment and/or transport, public savings could top $500 million per year, with societal savings doubly as large if private insurance companies were to follow suit.

Private Sector Profit Maximization

Constrained by current medical insurance reimbursement policy, EMS organizations may be responding dependent on ownership type. The concept of self-interest in an open market was advanced by Adam Smith (1776) and lays the behavioral foundation for the for-profit organization. This basis of economic thought views the private business as profit-maximizing. Paul Samuelson (1947) later demonstrated the underpinnings of Smith's concept and developed the mathematical argument that private for-profit firms act as profit-maximizers.

Since the Reagan administration, local governments have increasingly chosen to contract public functions to private companies (Cooke, 2008) as the idea of "small government" has gained popularity. Included in this upward trend is the provision of emergency ambulance services. Scholars have noted that both the choice to contract and through which sector to contract is highly dependent on the nature of the service itself (Ferris & Graddy, 1986) with EMS being contracted to for-profit organizations more often than non-profit (37.3% and 29.2%, respectively).

Samuelson's view of profit-maximization in the private sector leads us to expect that private for-profit ambulance agencies will behave in such a way that would maximize the difference between total revenue and total cost. Through the reimbursement policies of health insurance payers, for-profit ambulance organizations are incentivized to provide transport to the hospital for 9-1-1 patients, even when alternative means of treatment and/or transport may be more appropriate. In the hospital industry, researchers have identified instances of for-profit self-interest. Silverman and Skinner (2004) found that for-profit hospitals were more likely to engage in "upcoding", coding each Medicare patient in such a way as to maximize the reimbursement rate. For-profit hospitals have also been noted to be more likely to provide profitable medical services when compared to non-profit and government hospitals (Horwitz, 2005).

Non-Profit Quality Maximization

The private non-profit firm may differ from the for-profit firm in regards to the maximization objective. In his treatise, Newhouse (1970) presents non-profit hospital behavior as quality maximizing. While non-profit firms are restricted by a break-even point, firms will choose to produce the highest quality product while maintaining average cost equal to average revenue.

Taking a societal view, the community strives to not only produce needed quantity, but to produce a service that yields quality as well. Subject to budgetary constraints, the non-profit firm must maximize this quantity-quality decision. Chen, et al. (2009) illustrate this notion by showing that non-profit hospitals with strong financial performance tend to provide more unprofitable services, such as mental health and behavioral services, than do their weakly performing counterparts. Furthermore, Deneffe and Masson (2002) analyzed Virginia hospitals and concluded that the non-profit hospitals within their sample chose to maximize social welfare (i.e.: quality) as opposed to profit or output maximizing. Findings of past research have also suggested that non-profit hospitals were cognizant of a budget constraint, further aligning with Newhouse's theory (Deneffe & Masson, 2002).

For the private non-profit EMS agency, service quality may be emphasized. Revenue, however, remains an important input in the agency's operating budget. Thus, the quality of service must be weighed against the revenue needed to break even with organizational costs. This creates an environment in which the non-profit agency behaves similarly to the for-profit firm in regards to patient transport, but only up to the revenue/cost breakeven point (which is estimated during the budgetary process and monitored throughout the fiscal year). Beyond this breakeven point, however, the non-profit firm is free to pursue other organizational goals.

Bureaucratic Budget Maximization

As the largest provider of EMS services in the Virginia EMS dataset (responding to 70% of all 9-1-1 calls), it must be determined what a public organization will maximize through its operation. Public entities do not answer to stockholders, thus the profit maximization view is not applicable. Observing this discrepancy, William Niskanen (1971) set forth a theory of bureaucratic budget maximizing behavior.

Niskanen's (1971) supposition noted the link between increased agency budget size and increased bureaucratic power, leading him to conclude that self-interest takes the form of budget maximizing behavior in public agencies. This view was later refined to regard public organizations as maximizing their discretionary budget (Niskanen, 1991). Niskanen viewed the public agency as a special type of non-profit entity, with a unique relationship with its financial sponsor (e.g.: city council). The agency, therefore, is solely reliant on this sponsor. In order to avoid duplication of services, the agency has no public competition. Also, the sponsor, providing total budget resources, is the sole purchaser of the agency's product. What has been noted as a bilateral monopoly (Cooke, 2008), with one buyer and one seller, the agency trades its output for the sponsor's budgetary resources. Thus, the agency's power and reputation are directly related to budget size (Niskanen, 1971, 1991), with a more powerful department able to extract additional funds from its sponsor.

In regards to EMS function, the publicly supported agency will seek to increase its annual budget by showing increasing relevance. That is, the public EMS agency will respond to as many calls as possible each year. Moreover, ambulance transport to the hospital takes a considerable amount of time, leaving fewer ambulance units available for additional patient contacts. With a lower proportion of patient transport, the publicly funded EMS agency is freer to respond to more 9-1-1 calls, thus increasing its call volume.

Public funding systems based upon agency output (e.g.: EMS call volume) are commonplace (Robinson, 2002). This system of funding is determinate upon a defined product of the agency and its success is heavily dependent on a standardized output (Robinson, 2002; Lee, et al., 2013). Public EMS agencies, as a result, define their product and output as call volume. Output funding is evidenced in the American health care sector by the prevailing fee-for-service and prospective payment systems. EMS call volume has become the standard metric from which to most effectively estimate operational expenses. Within the EMS realm, Ho and Ni (2005) noted that 20 of the 30 largest American cities reported at least one performance (outcome) measure for local fire and/or EMS departments. Just 50% of cities, however, subsequently compared performance objectives with actual results (Ho & Ni, 2005), suggesting that outcome measures may be less significant relative to output. Ho and Ni (2005) further reported that nearly 47% of fire/EMS "performance" measures were essentially output measures. Additionally, the authors noted that another 15% of "performance" measures related to inputs or efficiency (input-to-output ratios) measures and not explicit agency outcomes (Ho & Ni, 2005). More broadly, the Government Accountability Office has reported that federal agencies also tend to emphasize efficiency measures when reporting performance (GAO, 2010).

In the emergency services sector, researchers have provided evidence that supports Niskanen's (1971, 1991) viewpoint. Following the implementation of the Comprehensive Crime Act of 1984, local police agencies were allowed to retain any confiscated assets as a result of drug enforcement activities. Benson, et al. (1995) found that the resultant behavior indicated that police agencies significantly increased drug-related arrests relative to violent and property crimes. Consistent with the bureaucratic budget maximization theory, the data suggest that police agencies were incentivized to increase their discretionary budgets through the new revenue stream of drug enforcement (Benson, et al., 1995). Thus, policing activities were subsequently shifted towards drug enforcement.

Hospital Literature

Although there is a dearth of literature pertaining to EMS organizational function, several studies have outlined the operational and outcome differences among for-profit, non-profit, and publicly funded hospitals (Keeler, et al., 1992; Yuan, et al., 2000; Ettner & Hermann, 2001; Devereaux, et al., 2002a; Devereaux, et al., 2002b). Researchers have attempted to quantify measurable differences between for-profit hospitals and non-profit/public hospitals. While these hospitals may function, internally, in a similar fashion, their outcomes are not quite as analogous. In a meta-analysis of hospital outcomes and quality, Devereaux, et al. (2002a) found that, among the adult population and adjusting for meaningful confounders, for-profit hospital ownership was associated with an increased risk of mortality (relative risk of 1.02). An additional meta-analysis found that for-profit hemodialysis centers were also associated with a greater risk of death (relative risk of 1.08) (Devereaux, et al., 2002b). Yuan, et al. (2000) also note that risk-adjusted 30-day mortality rates were higher for patients treated at for-profit hospitals (relative risk of 1.03) but the difference was mitigated by the teaching-hospital status of the institution.

Similarly, there have been noted differences in cost and spending among hospitals of differing ownership type. Adjusted total per capita Medicare spending has been found to be higher in locales where all hospitals were for-profit (Silverman, et al., 1999). Medicare payments for patients admitted to for-profit hospitals six months following a significant health event have been noted to be higher than for patients admitted to other hospital types (Sloan, et al., 2001). Hospital expenditures in locales with the presence of a for-profit hospital have been noted to be more than 2% lower without affecting patient outcomes (Kessler & McClellan, 2002). Furthermore, administrative costs seem to be of consequence as well, with for-profit hospital ownership status associated with a 7.9 percentage point increase in administrative spending as compared to public hospitals, and a 5.7 percentage point increase as compared to non-profit hospitals (Woodhandler & Himmelstein, 1997).

Generally speaking, regardless of hospital ownership type, organizations face the same reimbursement rates from insurers. Thus, organizational responses to fixed prices may be different for the business-minded for-profit hospital. Attempting to maximize the difference between revenue and cost, fixed prices leave few options for increasing revenue. Thus, decreasing operational cost may be a more efficient strategy. Hirth, et al. (2000) noted that for-profit hospitals tended to provide lower technical quality of care (i.e.: older medical technology, lack of state-of-art equipment) but offered more amenities to their patients and visitors. Conversely, non-profit institutions were instead found to prefer higher technical quality of care over increased amenities. While for-profit hospitals have been observed to favor locations with a better-insured population, they serve the same number of uninsured patients as non-profit organizations when located in equivalent areas (Norton & Staiger, 1994). Pattison and Katz (1983) also observed no difference in patient insurer-mix among hospital ownership types in the same market area.

DATA & METHODOLOGY

This dissertation section will examine the operational differences between EMS organizations based upon organizational ownership type. Are private EMS agencies more likely to transport a given patient, as compared to their publicly funded counterparts? There appears to be a gap in the academic literature pertaining to differences between public and private organizations in the EMS industry. Disparities among ownership types concerning patient transport decisions are hypothesized to exist, with privately funded organizations being the most likely to engage in patient transport.

Data for this study have been provided by the Virginia Office of EMS and includes ambulance call data for the years 2009 through 2013 (inclusive). The Virginia Office of EMS collects ambulance call data on an ongoing basis, which is gathered by individual EMS organizations and reported to the Office of EMS. Data reporting in Virginia has been standardized based upon guidelines and data elements set forth by the National EMS Information System (NEMSIS). Currently, approximately 90% of U.S. states and territories collect data that are NEMSIS compliant and thus comparable across jurisdictions. Each EMS agency within a given state enters patient care data through an electronic reporting system. This data is then transferred to a state database, which is then used to build a national database. The dataset represents all 9-1-1 EMS calls for the included time period and was compiled by a professional state-level data manager. Furthermore, there are no gaps in the data concerning time period or geographic location (Virginia enjoys a 100% reporting rate).

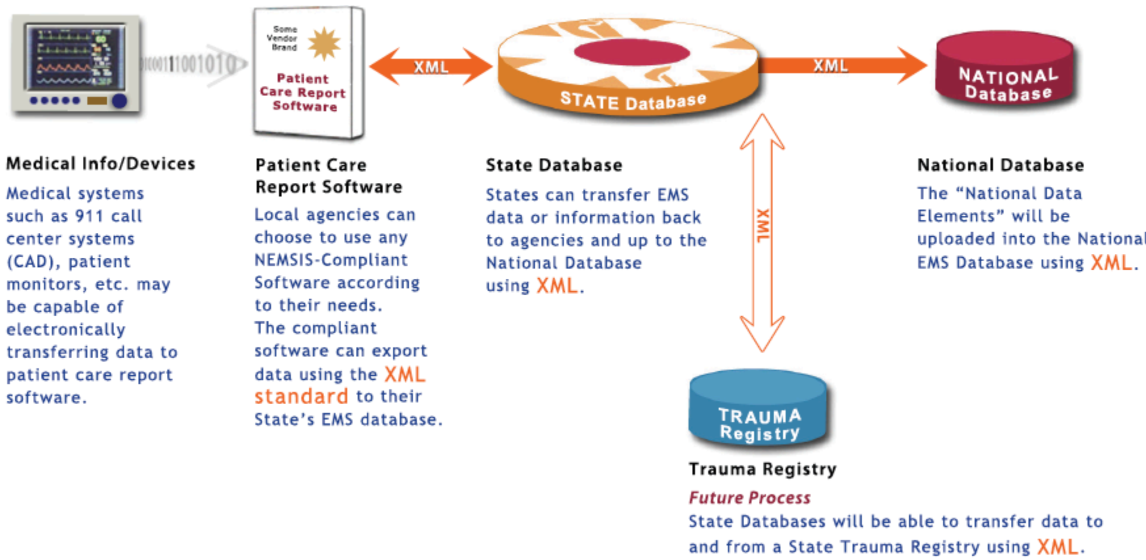

FIGURE 1: Patient data collection procedure

Source: National EMS Information System (NEMSIS)

EMS in the State of Virginia is organized and governed at the county level. Similar to other states, paramedic-level EMS care began in the 1970s and has since encompassed the entire state. The state currently offers five levels of pre-hospital medical provider: Emergency Medical Technician (EMT), Advanced Emergency Medical Technician (AEMT), Emergency Medical Technician-Intermediate (EMT-I)[2], Paramedic, and Critical Care Paramedic. Following the cessation of federal block grant funding for EMS system development, Virginia introduced its "One For Life" program in 1983. This legislation added one-dollar to each motor vehicle registration to support local EMS funding. Since expanded to "Four For Life" (since 2006), four-dollars per vehicle registration functions as a "return-to-locality funding" resource. Of each $4 fee, 26% is allocated towards the local provision of EMS regardless of contracting status (Virginia Office of EMS, 2011). Virginia began collecting EMS data in 1987 (trauma data only)

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[2] Virginia has adopted national recommendations to transition the EMT-I curriculum to AEMT but is maintaining both certifications until all personnel have completed the transition.

and has since grown to its present robust state that now incorporates 100% of EMS call and patient-contact information.

The state of Virginia was chosen for this study specifically due to its strong EMS dataset and public availability. Public access requests were submitted to the Virginia Office of Emergency Medical Services and the final dataset was developed with supportive and valuable input from the state's EMS data manager. EMS function in Virginia is also an effective sampling frame due to the state's demographics, geography, and economy. The state is comprised of distinct rural, suburban, and urban locales. These cities and towns are strewn across an area that includes mountain ranges, ocean beaches, and modern metropolitan infrastructure. Residents of Virginia are, approximately, 64% White, 20% Black, 7% Hispanic, and 6% Asian. Additionally, Virginia boasts the eleventh highest gross state product (GSP) per capita and was ranked in the top quarter[3] of states in regards to unemployment rate for the analyzed time period (2009-2013).

Dependent Variables

The outcome variable for this study is ambulance transport. When an emergency ambulance is summoned, the patient may legally accept both treatment and transport to a hospital, accept treatment but refuse transport, or refuse both treatment and transport. Transport categories are broken into dummy variables, measured dichotomously, and are mutually exclusive. The primary data category of interest is *Treated-Transported by EMS.* Other categories within this data element are *Treated – Transported BLS, Treated – Transported ALS, Treated and Released,* and *Patient Refused Care, Treated-Transferred Care, Treated-Transported by Private Vehicle, Treated-Referred to Law Enforcement, No*

[3] Unemployment rankings were 13th in 2009, 11th in 2010, 9th in 2011, and 13th in 2012 and 2013.

Treatment Required, No Patient Found, Dead at Scene, and *Cancelled.* Observations that were incomplete in regards to transport decision were dropped (N=7,845).

For analysis, the "transport" variable includes any patient whose transport category included *Treated-Transported by EMS, Treated – Transported BLS,* or *Treated – Transported ALS*. Each of these three categories represents patients who were treated and subsequently transported by an EMS agency. The distinction between BLS and ALS transport in the 9-1-1 setting does not affect this analysis. Additionally, the *Treated and Released* and *Treated-Transported by Private Vehicle* were included in the "treat-and-release" category. Finally, a category designated *Patient Refused Care* was included.

Independent Variable

The key explanatory for this study is organization ownership type. Ambulance services are categorized into one of five mutually exclusive groups. Publicly-funded EMS agencies fall into either the *Government–Non-Fire* or *Fire Department* categories while private organizations are included in the *Private Non-Profit, Private For-Profit,* or *Hospital* categories. It cannot be determined whether EMS organizations administered by hospitals are non-profit or for-profit in nature, thus a stand-alone category is necessary.

Only EMS agencies capable of 9-1-1 response are included for analysis. This excludes non-emergency convalescent ambulance response, critical care and air medical interfacility response, specialty resources (e.g.: hazmat or technical rescue), and 9-1-1 responses without a transport capable vehicle (e.g.: quick response vehicle). Further exclusionary criteria include mutual aid and intercept response (without transport), medical transport, and standby assignment.

Control Variables

Control variables include organizational employee mix, MSA location, ambulance response mode to the scene, patient's gender, patient's race, patient's age, and year fixed effects. For organizational employee mix, each agency is categorized as *Paid* (reference group), *Volunteer*, or *Mixed* (a combination of paid and volunteer personnel). MSA status is a dichotomous measure based upon the Metropolitan Statistical Area classification of the county in which the 9-1-1 call originated. Response modes include *Emergency Traffic* (either lights and sirens or lights-only) (reference group), *No Lights and Sirens, Lights and Sirens – Downgraded,* and *No Lights and Sirens – Upgraded*. Patient race is categorized as *White* (reference group), *Black, Asian,* or *Other*. Age is measured in years and gender is categorized as *Male* (reference group) or *Female*.

RESULTS

Statistical analysis was performed using R Statistical software (Version 3.1.2). A logistic regression model (with year-fixed effects) was utilized and average partial effects were estimated. Table 2 illustrates 9-1-1 requests and subsequent patient transport. Public agency transport rates were 56.5% and 61.8% (fire department and third-service, respectively). Private transport rates, however, were 73.6% and 89.5% (non-profit and for-profit, respectively). Hospital-based EMS agencies transported 79.9% of patient-contacts. Furthermore, fully-paid and fully-volunteer organizations transported approximately 64% of patient-contacts while mixed-personnel agencies transported roughly 61% of patient-contacts. The average transport rate among all organizational types and employee mix was 62.9%.

TABLE 2: Independent variables and control variables

Variable	N	Proportion	Standard Deviation	Transports (Proportion)	% Transported
PUBLIC					
Gov't–Non-Fire	458,836	9.89%	0.2983	283,345 (9.72%)	61.75
Fire Department	2,769,316	59.69%	0.4907	1,563,997 (53.63%)	56.48
PRIVATE					
Non-Profit	1,208,987	26.06%	0.4389	889,803 (30.51%)	73.60
For-Profit	180,480	3.89%	0.1934	161,543 (5.54%)	89.51
Hospital	21,753	0.47%	0.0682	17,398 (0.60%)	79.98
EMPLOYEE MIX					
Paid	1,471,873	31.73%	0.4651	950,245 (33%)	64.56
Volunteer	871,664	18.79%	0.3909	558,460 (19%)	64.07
Mixed	2,295,835	49.49%	0.4999	1,407,381 (48%)	61.30
RESPONSE MODE					
Emerg Traffic	3,080,666	86.95%	0.3368	1,883,850 (85.88%)	61.15
No Lights/Sirens	386,792	10.92%	0.3119	266,067 (12.13%)	68.79
L/S, Downgrade	25,295	0.71%	0.0842	13,763 (0.63%)	54.41
No L/S, Upgrade	43,468	1.23%	0.1101	27,899 (1.27%)	64.18
Mode Missing	6,775	0.19%	0.0437	1,953 (0.09%)	28.83
GENDER					
Male	1,674,979	36.05%	0.4802	1,253,627 (42.93%)	74.84
Female	2,081,760	44.81%	0.4973	1,614,585 (55.29%)	77.56
Unknown	889,117	19.14%	0.3934	52,186 (1.79%)	5.87

RACE					
White	2,420,776	52.11%	0.4996	1,866,688 (63.92%)	77.11
Black	1,042,195	22.43%	0.4171	798,969 (27.36%)	76.66
Asian	43,258	0.93%	0.0960	33,047 (1.13%)	76.40
Other	118,190	2.54%	0.1575	87,951 (3.01%)	74.41
Unknown	1,021,437	21.99%	0.4142	133,743 (4.58%)	13.09
AGE	4,639,372	--	25.23	--	--
YEAR					
2009	804,593	17.32%	0.3784	543,030 (18.59%)	67.49
2010	771,606	16.61%	0.3722	519,687 (17.80%)	67.35
2011	941,869	20.27%	0.4020	602,841 (20.64%)	64.00
2012	1,052,706	22.66%	04186	627,356 (21.48%)	59.59
2013	1,075,082	23.14%	0.4217	627,484 (21.49%)	58.37
TOTAL	**4,639,372**			**2,916,086**	**62.9**

Table 2 further shows the frequency of each independent variable and control variable. Public EMS agencies responded to 69.58% of all 9-1-1 requests and private EMS agencies responded to 29.95% of 9-1-1 requests. Hospital-based EMS agencies responded to 0.47% of 9-1-1 requests. Regarding employee status, 31.73% of responses were attended to by fully-paid personnel, 18.79% by fully-volunteer personnel, and 49.49% by a mixture if personnel-status.

Furthermore, 66.4% of 9-1-1 responses were attended to via “emergency traffic”. Female patients comprised a plurality in this dataset, involving 44.87% of patient contacts. Additionally, White patients comprised 52.18%, Black patients 22.46%, and Asian patients 0.93% of all patient-contacts. Average age in this dataset was 52 years with a standard deviation of 25 years.

Table 3 shows the estimated average partial effects for all explanatory and control variables. Using fire department responses as the referent, patients attended to by a third-service agency were shown to have a 3.3 percentage point increase in the probability of transport. Additionally, patients attended to by a private non-profit agency had an 11.6 percentage point increase in the likelihood of transport while those attended to by a private for-profit agency showed a 16.9 percentage point increase in the probability of transport. All findings for the organizational ownership variables were found to be statistically significant at a 1% alpha level.

TABLE 3: Adjusted[A] average partial effects of EMS ownership on probability of patient transport

Variable	dy/dx	P-Value
Org Type		
Fire Dept	Referent	--
Gov't–Non-FD	0.0337	<0.0001
Non-Profit	0.1156	<0.0001
For-Profit	0.1687	<0.0001
Hospital	0.1527	<0.0001
Employee Mix		
Paid	Referent	--
Volunteer	-0.0594	<0.0001
Mixed	0.0394	<0.0001

[A] Adjusted for EMS response mode, age, gender, race, MSA, and year fixed-effects.

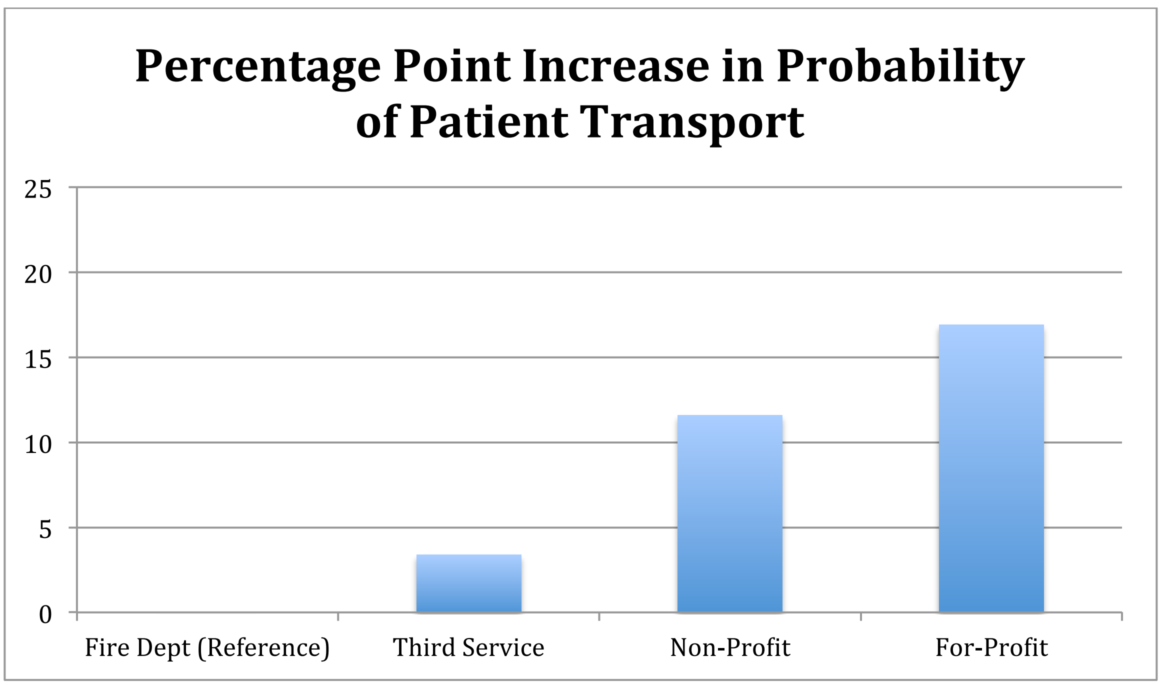

FIGURE 2: Probability of patient transport by ownership type

If the findings were to be extrapolated, and imagining a scenario in which all Virginia localities that currently contract with a private EMS agency were to shift EMS function to its local fire department, we can see that a number of patient transports become extraneous. Upwards of 170,205 additional patient transports occurred in the analyzed five-year timespan as a direct result of organizational ownership status (34,041 patient transports, annualized). This represents 5.8% of all patient transports in Virginia.

Calculations are shown below, where *APE* is the reported average partial effects (Table 3), *C* is number of 9-1-1 requests, and *T* is number of patient transports.

$$(1)\quad APE_{non-profit}(C_{non-profit}) + APE_{for-profit}(C_{for-profit})$$

$$(2)\quad \frac{APE_{non-profit}(C_{non-profit}) + APE_{for-profit}(C_{for-profit})}{T_{total}}$$

Taking a subset of the total dataset, patients aged 65 or over accounted for 1,459,114 emergency ambulance calls with a 77.3% transport rate. Average partial effects for this patient population were found to be 0.0964 and 0.1751 for non-profit and for-profit agencies, respectively (fire department agencies used as the referent). Applying the above equations, 56,049 (4.97%) patient transports occurred as a direct result of agency ownership status (11,208 patient transports, annualized). It is certainly not difficult to assume the whole of this aged population to be protected by Medicare insurance. Applying an approximate transport reimbursement amount of $450 per patient for the ALS1-Emergency transport category (CMS, 2014), Medicare may have misspent approximately $25.2 million in Virginia alone from 2009 to 2013. This amount is directly attributable to agency ownership and would undoubtedly multiply many times if applied to private insurers.

DISCUSSION

Findings of this analysis show that the probability of patient transport is increased between public and private EMS agencies. There also exists a difference in probability of transport between private non-profit and private for-profit organizations, with for-profit agencies more likely to engage in patient transport. Non-profit agencies are shown to be 11.6 percentage points more likely than fire department agencies to transport while for-profit agencies are 16.9 percentage points more likely. These findings support the hypothesis that disparities among ownership types concerning patient transport decisions are present, with privately funded organizations being the most likely to engage in patient transport due to differences in maximizing behavior.

This study contributes to the greater body of academic and professional knowledge by examining organizational ownership as a causal variable in relation to patient transport decisions. Organizational factors have remained overlooked as an explanatory mechanism in existing academic research concerning EMS and organizational ownership has now been shown to be of significant consequence. The data for this study provide a robust foundation from which to consider questions regarding EMS agency function.

With greater emphasis on the difference between revenue and cost, private EMS agencies appear to favor patient transport in relation to their public peers. Controlling for pertinent variables (such as EMS response mode, patient age, patient, gender, patient race, and MSA status), both private non-profit and private for-profit EMS organizations are more likely to transport a given patient in relation to their public-fire department brethren (11.56 and 16.87 percentage point higher probability of transport, respectively).

These findings support the hypothesis that private EMS organizations respond to market incentives that encourage costly transport. Economic theory suggests that private non-profit agencies behave similarly to for-profit organizations up until a budget-constraint break-even point. Existing theory explains the finding that private non-profit EMS agencies are more likely to transport a patient, but not as great an extent as a private for-profit agency.

Medical insurers have clear conditions for reimbursement of emergency ambulance services. Currently, patient transport is the most common service for which EMS agencies can bill. The Centers for Medicare and Medicaid Services has gone as far as to unambiguously define the ambulance benefit, stating, "the Medicare ambulance benefit is a transportation benefit and without a transport there is no payable service" (CMS, 2014). This restrictive reimbursement policy, duplicated by private insurers (regardless of patient age), may distort agency behavior by incentivizing transport to the hospital, whether appropriate or not.

Results of my analysis are consistent with the findings of past research in the hospital sector. Several studies have outlined the operational and outcome differences among for-profit, non-profit, and publicly funded hospitals (Keeler, et al., 1992; Yuan, et al., 2000; Ettner & Hermann, 2001; Devereaux, et al., 2002a; Devereaux, et al., 2002b). Medicare spending was been found to be higher in locales where all hospitals were for-profit (Silverman, et al., 1999) and Medicare payments for patients admitted to for-profit hospitals six months following a significant health event were shown to be higher than for patients admitted to other hospital types (Sloan, et al., 2001). Given the higher propensity towards patient transport, Medicare payments and spending may be similarly higher for for-profit EMS organizations.

There are, however, certain limitations that should be noted. The trade-off between internal and external validity is apparent. The data include 9-1-1 requests from the state of Virginia only. Therefore, it would be difficult to generalize the findings to other areas of the country. The advantage that the data present, however, is the allowance of each observational data point to be subject to the same laws concerning EMS operation. Additionally, the data represent 9-1-1 requests that include a varying macroeconomic environment, from recession-laden 2009 to the improved 2013 economic landscape. Further study can be inclusive of a greater geographical area, incorporating additional American states. Moreover, analysis can seek to include medical insurance billing data, which may more effectively detect for "upcoding" in the emergency ambulance industry between public and private ambulance agencies.

AMBULANCE TRANSPORT AS A SIGNALING MECHANISM

In an environment that places pressure on the reduction of health care spending, the provision of medical services deserves some level of scrutiny. Upon arrival to a hospital's emergency department, medical patients must describe highly subjective complaints (e.g.: pain or discomfort) to medical providers. Providers, in turn, must use this information in combination with objective assessment findings (e.g.: vital signs) to determine an efficacious diagnostic plan. In this case, the *sender* (the patient) must convey information about himself to a *receiver* (the physician) through the use of signals. For a large swath of the general public, detailed medical knowledge is rare. Thus, a simple description of one's medical problem is not an efficient means of signaling. Due to the imperfect balance of information, the application of Spence's (1973) work on signaling theory leads to the idea that patients are utilizing ambulance transport as an information conveyance mechanism and lends weight to the question: Are ambulance patients more likely than otherwise similar non-ambulance patients to receive diagnostic testing in the emergency department?

This dissertation section examines the effect of ambulance transport to the emergency department on the probability of diagnostic testing provision while controlling for pertinent confounders. I expand on previous research by applying the theoretical framework of signaling. I consider the initial actions of emergency department physicians (operationalized as the provision of diagnostic testing), and utilize propensity score matching techniques. The analysis examines emergency department data from 2007 to 2010, gathered from the National Hospital Ambulatory Medical Care Survey.

LITERATURE REVIEW

Michael Spence's (1973) seminal work on signaling theory addresses the issue of imperfect information between two parties. In his treatise, Spence (1973) explores a job-market signaling model. This model posits that potential employees are fully aware of their intrinsic ability while potential employers are unaware of this unobservable characteristic. In light of this asymmetric information, the employer readily accepts one's educational attainment as a valid signal of greater ability.

Spence's work is applicable to numerous disciplines. Within the realm of emergency medicine and emergency services, ambulance utilization may be viewed as a signal. In the case of ambulance transport to the ED, the patient acts as a signal *sender*, having subjective information about his perceived condition known to him. The physician acts as a signal *receiver*, obtaining the information through the use of a signaling mechanism. Spence (1973) posits that once an informational signal is accepted, the *receiver* will adjust his behavior accordingly. For purposes of this study, physician behavior is measured through the provision of specific diagnostic testing services. This measure focuses on a time-point in which the patient's medical condition is relatively unknown to the physician. Thus, the physician must pursue a course of diagnostic testing based upon what little information is available to him. It is not until the diagnostic testing process is complete that the physician can then move on to a definitive treatment phase.

Various studies have focused on instances of asymmetric information in the health care arena (Robinson, 1988; Choongsup, 1995; Schneider, 2004; Jae-Young, 2007; Schneider & Volker, 2008; Friehe, 2009; Lim & Jo, 2009; Wang, et al., 2011; Mascarenhas, et al., 2012). Of the numerous consequences of information asymmetry, increased utilization has been noted to be of unique importance (Arrow, 1963; LaBelle, et al., 1994; Grytten & Sorensen, 2001; Chou, 2002). In these models, however, the primary effect of asymmetric information is the emergence of monopoly power for health care providers. In stark contrast, the imbalance of information pertaining to one's unknown medical condition in an emergency setting may instead significantly shift power from the physician to the patient. The physician, acting as a normal risk-averse individual (Fiscella, et al., 2000; Katz, et al., 2005; Tubbs, et al., 2006; Coricelli, 2008), may be more inclined to over-utilize medical resources in order to avoid misdiagnosis and subsequent personal liability. If physicians accept ambulance transport as a valid signal of more severe acuity levels, it is argued that they will perceive a greater risk of non-action (here, operationalized as the absence of a diagnostic or imaging test) for ambulance patients and therefore be more prone to order tests for this subset of patients.

Literature pertaining to ED physician perception of "appropriate use" of ambulance services find that 10% to 42% of ambulance transports are medically unnecessary (Gibson, 1977; Rademaker, et al., 1987; Gardner, 1990; Billittier, et al., 1996; Jacob, et al., 2006; Gratton, et al., 2003; Patton and Thakore, 2012), with the majority of findings concentrating around the 30% mark (Gibson, 1977; Gardner, 1990; Jacob, et al., 2006; Gratton et al., 2003; Patton and Thakore, 2012). These studies of unnecessary emergency ambulance utilization were accomplished using retrospective patient chart review (Gibson, 1977; Patton and Thakore, 2012) or a determination upon patient arrival using prospective sampling methods (Rademaker, et al., 1987; Gardner, 1990; Billittier, et al., 1996; Jacob, et al., 2006; Gratton, et al., 2003). Patients under the age of 40 have been found to be the most likely to unnecessarily utilize EMS services (Billittier, et al., 1996).

In the case of emergency department presentation, it is argued that patients are not signaling their true acuity level through the use of an ambulance, but instead their perceived acuity level. There still exists an abundance of uncertainty concerning one's personal medical condition when presenting oneself to a health care provider. Without medical training or experience, there is often very limited confidence afforded to a particular set of subjective medical symptoms (Gardner, 1990). This, in turn, may lead a normally risk-averse individual to consider or assume the worst of any given set of symptoms. These dire assumptions must then be conveyed effectively to a health care provider if one believes his condition to be emergent.

Personal perception of one's medical condition is sharply different between ambulance and non-ambulance patients. Ambulance patients have been found to be more likely to call an ambulance for *any* health concern and felt as though there were enough ambulance resources for all patients at any given time. These patients were also more likely to have used EMS transport in the past year (Pearson, et al., 2010). Furthermore, perceptions of medical acuity level are highly skewed. It has been noted that ambulance patients are more likely to assert that their illness required care within one hour of arrival (Pearson, et al., 2010). Of those who have been deemed to have utilized an ambulance inappropriately, 20% of low-acuity patients stated they were "too sick" to travel by means other than emergency ambulance (Jacob, et al., 2006).

While it has been found that ambulance arrival reduces patient ED wait time (Richards, et al., 2006), very few cases require emergency attention[4]. However, when surveyed, patients' perception of urgency revealed that 82% of ambulance patients rated their presenting condition as urgent, with expediency as the most common reason for transport to the emergency department (Gill and Riley, 1996). Further study of personal perception of acute illness found that frequent emergency department users have an, "…overwhelming anxiety" and fear that their symptoms pose a threat to life (Olsson and Hansagi, 2001, pg. 430). Although ambulance transport is commonly associated with emergency conditions and situations, Richards and Ferrall (1999) found 47% of ambulance patients had access to private transportation but chose not to utilize it. Although previous research has explored the issue of medically unnecessary ambulance transport, the act of physical arrival to the ED via ambulance has yet to be considered as a signal.

[4] In the analyzed data set, only 3.2% of cases were triaged as immediate emergencies.

DATA & METHODOLOGY

Data for this study was collected from the National Hospital Ambulatory Medical Care Survey (NHAMCS), Emergency Department Edition for the years 2007–2010 (inclusive). For analysis, logistic regression was employed. Average partial effects were then estimated and robust standard errors were utilized for inference.

Conducted by the Centers for Disease Control and Prevention (CDC), the NHAMCS (ED) is a national probability sample of patient visits to emergency departments of non-institutional general and short-stay hospitals in the fifty states and the District of Columbia. The sample excludes federal, military, and Veterans Administration hospitals. The NHAMCS employs a four-stage probability sampling design to build a sampling frame, from which approximately 500 hospitals were chosen for inclusion. The participation rate was approximately 90% (hospitals may decline study involvement). Patient visits were randomly selected from each hospital over an assigned four-week period for the given survey year. A patient visit is defined as, "…a direct, personal exchange between a patient and a physician, or a staff member acting under a physician's direction, for the purpose of seeking care and rendering health services." (CDC, 2007) Thus, visits expressly made for administrative purposes, such as the payment of a bill or the delivery of a specimen, are not included.

Data Subset

I subset the primary data set based upon the initial triage category assigned to each patient by the receiving hospital. Upon arrival to an emergency department, each patient is assigned to a triage category. This category denotes what length of time the medical provider (typically a nurse) believes the patient can wait before seeing a physician without incurring any negative effects to health or safety. In the analyzed dataset, patients fall into one of five triage categories (*Immediate, 1 – 14 minutes, 15 – 60 minutes, 1 – 2 hours,* and > *2 hours*) with the highest acuity patients included in the *Immediate* classification while the lowest acuity patients are included in the >*2 hours* category.

Although there is no nationally mandated protocol for emergency department triage, there has been an increasing trend towards standardization since 2000 (Gilboy, et al., 2011). Development of the Emergency Severity Index (ESI) in 1999 has created a standardized and consistent means through which to categorize the severity of a given patient's medical condition. As of 2009, 63% of hospitals employed a five-level triage system (McHugh & Tanabe, 2011). The CDC has adapted the ESI system into a five-level time-based categorization system when compiling nationwide data. Of 136,147 total observations, 4,757 were missing transport mode and 15,239 were missing triage level or were not triaged, with some observations missing both transport mode and triage level. 120,908 observations were used for analysis.

Dependent Variables

The dependent variables reflect specific diagnostic and imaging tests commonly used for the diagnosis of medical conditions. Within the NHAMCS data, nineteen diagnostic tests are available for inclusion and are measured dichotomously. Fifteen tests were included in the final analysis (see Appendix A: Description of Diagnostic Tests). The diagnostic tests that were not be included in the final analysis are either very uncommon (blood alcohol content, toxicology screening) or overly commonplace (flu test, pregnancy test) resulting in very little variation within the sample. One imaging test (MRI) was analyzed despite its low-frequency use. Its inclusion is due to the test's high cost and use of highly specialized equipment. 35,517 (29.4%) of patients received no diagnostic or imaging services. The provision of diagnostic testing was chosen as a measure due to its timing in the patient-physician interaction sequence. It is posited that shifts in physician behavior, due to patient signals, can be effectively measured through observed disparities in diagnostic provisions between ambulance and non-ambulance patients.

TABLE 1: Diagnostic services and frequency of provision

Abbreviation	Description	Patients Receiving Test	EMS Arrival	Non-EMS	Unk
CBC	Complete Blood Count	45,171 (37%)	12,648 (28%)	31,283 (69%)	1,240 (3%)
BUN	Blood Urea Nitrogen	31,070 (26%)	9,320 (30%)	20,977 (68%)	773 (3%)
ENZYMES	Cardiac Enzymes	17,137 (14%)	6,092 (36%)	10,591 (62%)	454 (3%)
ELECTROLYTES	Electrolytes	27,600 (23%)	8,415 (31%)	18,434 (67%)	751 (3%)
BGL	Blood Glucose Level	28,527 (24%)	8,745 (31%)	19,090 (67%)	692 (2%)
LFT	Liver Function Test	12,422 (10%)	3,770 (30%)	8,359 (67%)	293 (2%)
ABG	Arterial Blood Gas	4,571 (4%)	1,869 (41%)	2,600 (57%)	102 (2%)
PT/INR	Prothrombin Time	10,192 (8%)	3,813 (37%)	6,063 (60%)	316 (3%)
BCULTURES	Blood Cultures	6,188 (5%)	2,159 (35%)	3,842 (62%)	187 (3%)
MONITOR	Cardiac Monitoring	10,879 (9%)	4,683 (43%)	5,925 (55%)	271 (3%)
EKG	12-Lead Electrocardiogram	22,020 (18%)	8,312 (38%)	13,128 (60%)	580 (3%)
URINE	Urine Analysis	29,499 (24%)	7,136 (24%)	21,594 (73%)	769 (3%)
XRAY	X-Ray (Any Body Part)	42,149 (35%)	10,497 (25%)	30,530 (72%)	1,122 (3%)
CAT	CAT Scan (Any Body Part)	17,792 (15%)	5,846 (33%)	11,521 (65%)	425 (2%)
MRI	MRI (Any Body Part)	779 (1%)	226 (29%)	529 (68%)	24 (3%)
NONE	No Diagnostic Services	35,517 (29%)	1,517 (4%)	33,003 (93%)	997 (3%)

Independent Variable

The key explanatory variable for this study is patient arrival to the emergency department via ambulance, measured dichotomously. The "ambulance" mode of arrival includes patients arriving to the emergency department via air or ground units and includes both Advanced Life Support and Basic Life Support ambulance units. The non-ambulance designation denotes any non-ambulance means of transport and includes *private vehicle, taxi, public transportation, walk-in,* and *other*.

Patient observations were matched and separated into "treatment" (ambulance arrival mode) and "control" (non-ambulance arrival mode) groups using propensity score matching techniques. Utilizing a "nearest-neighbor" propensity score matching technique, it was possible to directly compare the two relatively different patient groups. Patients were matched on age, gender, race, ethnicity, insurance status, neighborhood poverty level, residential status, emergency department wait-time, and hospital admission decision.

Matching techniques were utilized due to the character of the independent variable. Within the sample, mode of arrival the to ED was self-selected. During the data collection period, no protocol was created to randomly assign patients to either the ambulance group or non-ambulance group. Subsequently, disparities were noted between the two groups in terms of patient demographics and hospital-visit characteristics. Matching was employed to better control for these disparate attributes by pairing each ambulance patient to a similar non-ambulance patient of equal likelihood of being in the ambulance transport group. By calculating and matching on propensity score, the aim was to reduce estimation bias created by self-selection of arrival mode group.

Control Variables

Control variables include patient's age measured in years, gender (male or female), race (White, Black, or Other), and ethnicity (Hispanic or non-Hispanic). Adjustments for patient insurance status include *private payer, Medicare, Medicaid, Worker's Compensation coverage, self-pay,* and *other*. Controls for neighborhood poverty level are categorized into four levels based upon the percentage of residents in the patient's ZIP code living below the Federal Poverty Level. Poverty categories include l*ess than 5%, 5% to 9.99%, 10% to 19.99%,* and *20% or greater*, The patient's residential status is taken into account and includes *private home, nursing home, other residence, other institution,* and *homeless*.

Actual emergency department wait-time is also controlled for and is measured continuously in minutes from arrival to physician contact. The subsequent hospital admission decision for each patient is included and measured dichotomously (admitted to in-patient nursing unit or discharged from the ED). Although the hospital admission decision occurs after the diagnostic process, ambulance patients in this sample are more likely to be admitted to an in-patient unit. Thus, the admission outcome serves as an additional control for medical acuity. Organizational controls include the U.S. region in which the treating hospital is located (*Northeast, Midwest, South,* and *West*), whether the treating hospital is located in a metropolitan statistical area (measured dichotomously), ownership status of the treating hospital (*non-profit, for-profit,* and *non-federal public*), and year fixed-effects.

RESULTS

After propensity score matching, employing a “nearest-neighbor” method, a final sample of 41,370 observations was obtained. These observations were equally split between ambulance and non-ambulance patients (Table 2). The most common triage category was *15 – 60 minutes*, representing 49% of patients regardless of arrival mode while the *Immediate* and *> 2 hours* categories each represented 6% of patients. The proportion of ambulance patients for each triage category followed an expected pattern. The *Immediate* category saw the largest proportion of ambulance patients (72%) and the *> 2 hours* category saw the smallest proportion of ambulance patients (33%) with a consistent gradient between the two categories (Table 2).

TABLE 2: Patient presentation by EMS transport and acuity level

	Unmatched Group			Matched Group		
Category	**N**	**Ambulance**	**Non-Ambulance**	**N**	**Ambulance**	**Non-Ambulance**
ARRIVAL MODE	120,908 (100%)	20,685 (17%)	100,223 (83%)	41,370 (100%)	20,685 (50%)	20,685 (50%)
TRIAGE CATEGORY						
Immediate	3,905 (3%)	1,724 (44%)	2,181 (56%)	2,382 (6%)	1,724 (72%)	658 (28%)
1 – 14 Min	14,959 (12%)	4,615 (31%)	10,344 (69%)	7,696 (19%)	4,615 (60%)	3,081 (40%)
15 – 60 Min	54,893 (45%)	10,238 (19%)	44,655 (81%)	20,326 (49%)	10,238 (50%)	10,088 (50%)
1 – 2 Hours	36,175 (30%)	3,339 (9%)	32,836 (91%)	8,605 (21%)	3,339 (39%)	5,266 (61%)
> 2 Hours	10,976 (9%)	769 (7%)	10,207 (93%)	2,361 (6%)	769 (33%)	1,592 (67%)

Table 3 shows the mean value for each control variable, both prior to and following data matching. After compiling a matched sample, the average age of all ambulance patients was 52 years and the average age of non-ambulance patients was 53 years. Women constituted 53% (ambulance and non-ambulance) of patient encounters. White patients comprised of 71% (ambulance) and 75% (non-ambulance) of the sample, Black patients 24% (ambulance) and 21% (non-ambulance, and Other patients 5% (ambulance and non-ambulance). 13% of ambulance and non-ambulance patients were Hispanic.

A plurality (43%) of non-ambulance patients had private health insurance (Table 3) but ambulance patients were most likely to have Medicare insurance (37%). 29% of ambulance patients and 23% of non-ambulance patients had Medicaid insurance. 14% of patients (ambulance and non-ambulance) had no insurance coverage and were categorized as self-pay.

34% of ambulance patients were subsequently admitted to an in-patient unit while 33% of non-ambulance patients were admitted (Table 3). From the moment of arrival to first contact with a physician, ambulance patients waited an average of 38 minutes and non-ambulance patients waited an average of 40 minutes. A majority of patients were seen and treated at a private non-profit hospital (73% of ambulance patients and 74% of non-ambulance patients). Private for-profit hospitals saw 19% of ambulance patients and 16% of non-ambulance patients. Public (non-federal) hospitals saw 8% of ambulance patients and 10% of non-ambulance patients.

As a robustness check of the propensity score matching algorithm, a logistic regression was analyzed using ambulance transport as the outcome variable and the control variables as explanatory variables. With a successfully matched sample, the control variables, on which patients were matched, should not be significant indicators of arrival mode to the ED. P-values for this regression are presented in Table 3. All explanatory variables were found to be statistically insignificant at the 10% alpha level. After successfully matching, the control variables did not significantly explain the likelihood of patient arrival to the ED via ambulance.

TABLE 3: Control variable means

Variable	Ambulance	Non-Ambulance (Unmatched)	Non-Ambulance (Matched)	P-Value
AGE	51.9	34.1	52.7	0.3581
GENDER				
Female	53.2%	54.5%	52.7%	0.1463
Male	46.8%	45.5%	47.3%	Referent
RACE				
White	71.4%	71.0%	74.6%	Referent
Black	23.7%	24.3%	20.9%	0.1789
Other	4.9%	4.8%	4.5%	0.3424
ETHNICITY				
Non-Hispanic	87.4%	85.6%	86.9%	Referent
Hispanic	12.6%	14.4%	13.1%	0.4825
INSURANCE				
Private	32.9%	39.4%	43.4%	Referent
Medicare	37.4%	13.5%	31.2%	0.1050
Medicaid	29.1%	30.0%	22.6%	0.4430
Self-Pay	14.1%	17.7%	13.9%	0.6235
Workers Comp	0.9%	1.4%	1.3%	0.5140
Other	4.6%	3.4%	3.5%	0.2922
No Charge	1.2%	1.5%	1.2%	0.6446
Don't Know	4.2%	4.3%	3.7%	0.9553
POVERTY				
< 5%	14.6%	13.9%	16.7%	Referent
5% - 9.99%	23.9%	24.5%	26.0%	0.8713
10% - 19.99%	31.4%	34.8%	32.7%	0.6130
20% +	24.5%	21.7%	19.8%	0.3141
WAIT TIME	37.5	48.9	40.1	0.1417
MSA	90.2%	86.3%	90.4%	0.9655
REGION				
Northeast	31.7%	23.9%	30.4%	Referent
Midwest	19.4%	20.7%	21.6%	0.2745
South	32.6%	37.5%	31.9%	0.8230
West	16.3%	17.9%	16.2%	0.1883
OWNERSHIP				
Non-Profit	73.3%	74.1%	74.1%	Referent
For-Profit	18.5%	16.3%	16.3%	0.6894
Public	8.3%	9.6%	9.6%	0.8223

Table 4 presents the average partial effects of ambulance transport by each triage category. Findings indicate that arrival to the ED via emergency ambulance is associated with an increased likelihood of diagnostic testing across all triage groups. Ambulance transport had a positive and statistically significant effect on the provision of most diagnostic services. MRI testing, however, was not affected by arrival mode in a statistically significant manner.

Another trend that emerged from the analysis was one of increasing effect of the ambulance signal as the triage category became less acute. Within the *Immediate* triage group, 12 of the 15 diagnostic services saw statistically significant effects (5% alpha level) while 14 of the 15 diagnostic services were statistically significant in the *>2 hours* triage group. For example, ambulance patients in the *Immediate* triage category were 5.6 percentage points more likely than non-ambulance patients to receive CBC testing while those arriving by ambulance in the > *2hours* category were 14.3 percentage points more likely to receive the test. This trend was evident with 10 of the 15 diagnostic services. There was no observed upward trend in the likelihood of ambulance patients receiving services for ABG and PT/INR blood testing, blood cultures, EKG monitoring, and CAT scan procedures. These five diagnostic services, however, were noted to have positive, statistically significant effects.

TABLE 4: Adjusted[A] average partial effects of ambulance transport on diagnostic services by triage category

Service	Immediate	1-14min	15-60min	1-2hrs	> 2hrs
CBC	0.0561**	0.0590***	0.0651***	0.1327***	0.1429***
BUN	0.0762***	0.0646***	0.0536***	0.0752***	0.1046***
ENZYMES	0.0278	0.0301**	0.0435***	0.0460***	0.0546***
ELECTROLYTES	0.0575**	0.0554***	0.0517***	0.0653***	0.0887***
BGL	0.0700***	0.0732***	0.0619***	0.0740***	0.1028***
LFT	0.0306+	0.0155	0.0159**	0.0316***	0.0490***
ABG	0.0691***	0.0313***	0.0112**	0.0144***	0.0189**
PT/INR	0.0515**	0.0272**	0.0181***	0.0351***	0.0217*
CULTURES	0.0257*	0.0232**	-0.0017	0.0043	0.0231*
MONITOR	0.0764***	0.0656***	0.0703***	0.0573***	0.0483***
EKG	0.0541**	0.0688***	0.1055***	0.1040***	0.0983***
URINE	0.0818***	0.0626***	0.0175**	0.0603***	0.0978***
XRAY	0.0825***	0.0592***	0.0907***	0.1014***	0.1339***
CATSCAN	0.1267***	0.1125***	0.0784***	0.1178***	0.1005***
MRI	0.0079+	0.0029	0.0017	0.0024	0.0003

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

[A] Adjusted for gender, race, ethnicity, age, wait time, region, ownership type, MSA, insurance type, poverty level, median income of patient's neighborhood, and year fixed-effects.

In addition to the statistically significant finding that ambulance transport to the ED increases one's likelihood of receiving diagnostic services (with an inverse relationship to one's acuity level), the magnitude of the effect should also be considered. The proportion of non-ambulance patients who subsequently received each diagnostic service and the observed average partial effects of ambulance transport on the likelihood of diagnostic provision for each service were compared. To obtain a measure of magnitude of the ambulance transport effect, the percent change in likelihood of receiving each service was calculated as shown below, where *APE* is the reported average partial effects for *i* diagnostic service (Table 4) and *PrNA* is the probability of receiving diagnostic service *i* as a non-ambulance patient.

$$(1)\quad \frac{(APEi+PrNAi)-PrNAi}{PrNAi}$$

As an example, 32.5% of non-ambulance patients received CBC testing. The APE observed for the *>2 Hours* group was found to be 0.1429 (or a 14.29 percentage point increase in the likelihood of these ambulance patients receiving the service). Thus, the predicted likelihood of receiving CBC testing for ambulance patients in the *>2 Hours* group was 46.8%, a 44% magnitude increase in likelihood of service provision between ambulance and non-ambulance patients (refer to Appendix B: Magnitude of Ambulance Transport Power for a complete table of diagnostic services).

Most diagnostic services exhibited similar magnitudes of change in likelihood of diagnostic services for ambulance patients. For the highest acuity group, *Immediate,* magnitude changes ranged from 17.3% to 39.5% for 9 of the 15 services. For the lowest acuity group, *>2 Hours,* magnitude changes ranged from 42.4% to 57.8% for 9 of the 15 services. Large magnitude changes in the likelihood of service provision for ambulance patients in the *Immediate* group were noted for ABG testing (255.9% increase), basic EKG monitoring (123.2% increase), and CAT scan services (106.5% increase). Large magnitude changes in the likelihood of service provision for ambulance patients in the *>2 Hours* group were also noted for CAT scan (84.5% increase), basic EKG monitoring (77.9% increase), and ABG testing (70.0%), albeit to a lesser extent.

Within the *Immediate* group, a 255.9% increase in the likelihood of receiving ABG testing was noted for ambulance patients. After analysis, the highest average partial effect for this service was observed in the *Immediate* category (Table 4). Patients in this acuity group are in the most dire of situations and likely to be in cardiopulmonary arrest or on the verge of arrest. Thus, it would be expected that these patients would require external ventilator support. Standard medical practice dictates that patients receiving external ventilator support should receive serial ABGs in order to monitor respiratory function. Therefore, the magnitude of the effect of ambulance transport on the probability of ABG testing is quite large.

The magnitude of the effect of ambulance transport on the probability of receiving basic EKG monitoring services was also high. A 123.3% increase in the likelihood of ambulance patients receiving the service in the *Immediate* group and a 77.9% increase in the likelihood of ambulance patients receiving the service in the *>2 Hours* group was noted.

In addition to BGL testing and 12-lead EKG monitoring, basic EKG monitoring is one of the analyzed diagnostic services that can be performed by a paramedic in the prehospital setting. Prior to arrival to the ED, the patient may have already been placed on the EKG monitor. Once care has been handed over to the ED staff, the physician may opt to simply continue EKG monitoring in favor of continuity of care.

The magnitudes of the effect of ambulance transport on the probability of receiving the remaining diagnostic services cannot be as easily explained. In emergency medicine, however, physicians might “cast a wide net” when presented with an unknown condition (whether real or perceived). Physicians may order a number of diagnostic tests in an attempt to isolate the unknown problem, similar to shooting several times into a bush in the hopes of striking the bird. Many of the analyzed services are conducted through simple blood draws (CBC, BUN, cardiac enzymes, electrolytes, BGL, LFT, PT/INR, blood cultures) and are low-risk from a patient safety perspective.

DISCUSSION

The findings suggest that otherwise similar patients transported to the hospital via ambulance are more likely to receive diagnostic testing than those who arrive by other means. The results are consistent with the notion that emergency department physicians readily accept ambulance transport as a valid signal of patient acuity, regardless of true medical acuity level. The physician, therefore, is likely to cast a much wider diagnostic net for the ambulance patient with the subconscious belief that this patient has more hidden medical conditions than does his non-ambulance counterpart. Consequently, patients transported to the hospital via ambulance may be receiving a disproportionate amount of medical resources in an increasingly cost-conscious environment.

Michael Spence's view of signaling in the presence of asymmetric information is directly applicable to the emergency services arena. Patients often present to the emergency department physician with subjective and vague, or incomplete, personal complaints. Medical terms, such as "nauseous" or "numb", may carry different meanings to separate patients and might not conform to the physician's medical definition (Spiro & Heidrich, 1983).

During this initial meeting, the physician must draw upon as many objective medical findings as possible before moving forward with the diagnostic process. Due to concerns of financial and labor efficiency, every diagnostic test is not going to be ordered for every patient. Thus, the physician must use available data to help determine which tests and services will be the most beneficial for symptom diagnosis and treatment. Findings such as patient presentation (skin condition or work-of-breathing) and vital signs can help guide the physician. Arrival to the ED by emergency ambulance is now argued to be of importance during this early junction in the medical process.

The findings of this study suggest that physicians in the ED accept ambulance transport as a valid signal of potential medical acuity. Just as most ambulance patients perceive their condition as requiring immediate attention (Gill and Riley, 1996), physicians appear to bias the provision of diagnostic services towards ambulance patients due to a misconception of acuity. In addition to the statistical significance of the findings, there is also a meaningful practical significance.

In an atmosphere that stresses resource management and fiscal prudence, physicians appear to exhibit a bias towards ambulance patients in regards to diagnostic provisions. Thus, it is in the best interest of the patient to present himself to the ED via ambulance regardless of medical necessity. This perverse incentive may lead to a strain on the pre-hospital emergency system and the potential excessive use of diagnostic resources within the ED.

DEMOGRAPHIC VARIABLES AS SIGNALS IN THE EMERGENCY DEPARTMENT

In the previous chapter, the basis for an ambulance signal was presented. Results found that patients arriving to the emergency department (ED) via ambulance are more likely to receive diagnostic services than non-ambulance patients. This dissertation chapter will continue the theoretical concept of signaling (Spence, 1973) in regards to ambulance arrival to the ED. In this case, however, the power of the ambulance-transport signal will be explored utilizing relatively homogeneous patient populations (i.e. subsets of the data) in an attempt to control for the influence of other potential confounders that may be correlated with ambulance transport.

Michael Spence (1973) set forth a theory of signaling concerning both adjustable and non-adjustable characteristics. There are many signals from which we can choose, such as education level or wardrobe choice. However, there are also many signals that we cannot choose, such as age or race. This dissertation section will examine the effects of the adjustable signal of ambulance transport on diagnostic provision in the ED and how non-adjustable characteristics such as age, gender, race, ethnicity, and neighborhood poverty may mediate or enhance the ambulance signal. Each unalterable trait is expected to affect the value of the ambulance transport signal as it relates to the provision of diagnostic testing in the ED.

LITERATURE REVIEW

In his theory of signaling in the labor market, Michael Spence (1973) states that employers make use of both alterable and unalterable personal characteristics when determining wages for potential employees. Spence's classic adjustable signal was that of educational attainment. That is, an alterable characteristic (education) helps signal a potential employee's quality (the higher the education, the higher the quality). In addition to alterable characteristics, unalterable characteristics such as age, race, or gender are also important (Spence, 1973).

By utilizing a quantifiable measure, Spence was better able to locate what he refers to as a "clean" signal. His initial work employed the use of education level as the primary adjustable signal. Education as a signal, in practice, served as a proxy for worker quality and subsequent productivity. An employer would, understandably, seek high-quality workers and favor those with higher levels of formal education. This preference towards highly educated workers is manifested through wages. The greater the education, the higher the supposed quality in terms of productivity and/or efficiency, thus the higher the wage will be for that worker.

This dissertation chapter seeks to uncover signals in the field of emergency medicine. In contrast to Spence's classic educational signal, the signal proposed here is that of ambulance transport to the ED. Since a patient's true level of illness is rarely known prior to a battery of diagnostic tests and procedures, the patient may choose the signal of ambulance transport to indicate his perceived medical acuity. Furthermore, if accepted, the ambulance signal will result in a greater provision of diagnostic services, similar to Spence's wage-outcome.

As Figure 1 illustrates, both alterable and unalterable signals may impact the outcome of diagnostic service provision. The provision of diagnostic services is dependent on patient acuity level and, as the previous chapter demonstrated, arrival mode. Unalterable characteristics such as age, gender, race, ethnicity, and poverty are also thought to affect both the effect of ambulance transport and perceived patient acuity. These unalterable traits will ultimately affect the utilization of diagnostic services.

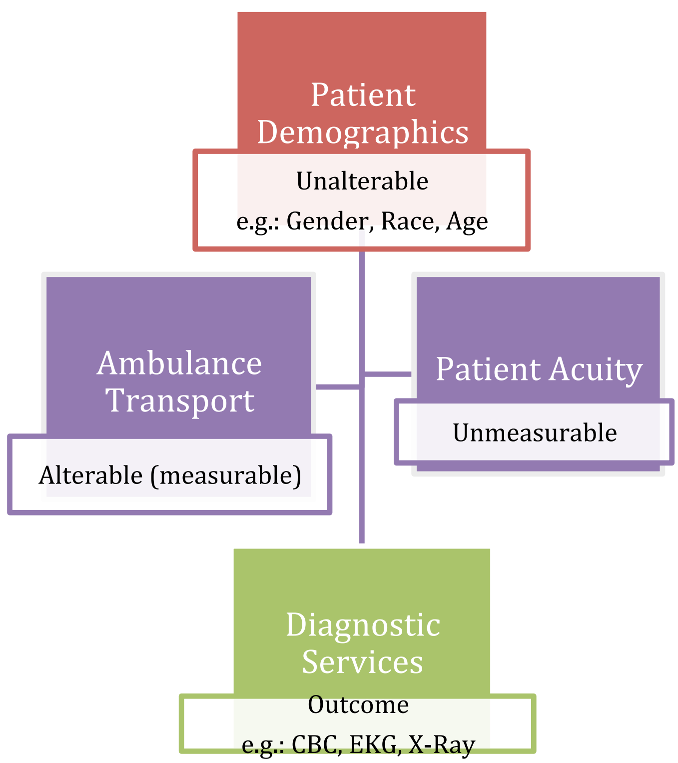

FIGURE 1: Impact of alterable and unalterable signals on the provision of diagnostic services in the emergency department

Unalterable Characteristics and Medical Utilization

Just as patients transported to the emergency department via ambulance may be viewed as more acute, it is hypothesized that younger adult patients may be viewed as less acute, thus minimizing the initial signaling effects of ambulance transport. Younger individuals, generally, will not suffer from the same chronic disease processes of their older peers, nor have multiple health conditions in a similar frequency. Thus, younger patients may be viewed as healthier than their older counterparts at baseline.

Furthermore, patients living in low-poverty neighborhoods may be seen as requiring fewer diagnostic tests even though they may be no healthier than patients from high-poverty neighborhoods. This idea is based on the notion of access to quality medical care. As one's income rises so does one's access to primary care and other quality medical services (Weissman, et al., 1991; Bindman, et al., 1995; Baker, et al., 2000; Fiscella, et al., 2000a). Uninsured individuals are more likely to report that they could not see a physician due to cost than their insured peers, especially among those of low health (Ayanian, et al., 2000). Consequently, higher-income patients will be able to more easily follow-up with a primary care or specialist physician, negating the need for an overly broad battery of diagnostic testing to occur in the emergency department setting.

Finally, while patient demographics are typically not self-selected they still may significantly factor into the determination of diagnostic provisions. There may exist differences in which men and women are perceived in the emergency department setting. Additionally, minority patients may experience diagnostic-testing disparities as well when presenting to an emergency department physician.

Additionally, these unalterable signals suffer from a perception disparity. Patients who are perceived to be "likable" and "competent" receive enhanced care from their medical providers (Gerbert, 1984). Patient race and socioeconomic status has a direct effect on perception in the medical setting. Physician perception of a patient's intelligence, avoidance of risky behavior, and adherence to medical advice are each negatively affected for Black and low socioeconomic status patients (Van Ryn & Burke, 2000) and result in differences in the provision of expensive medical interventions between African-American and White patients (Giacomini, 1996).

Hispanic patients also experience differences in care. When studying health utilization data, Harrell and Carrasquillo (2003) found that approximately one-third of Latinos had not seen a physician in the past year (compared to 16% of whites and 12% of blacks). Additionally, Latinos are less likely to receive guideline-recommended preventative care than non-Latino whites (Bustamante, et al., 2010). Compared to blacks and whites, Hispanics were the most likely to report delays in care, difficulties finding care, and unmet health needs (Zuvekas & Tallaferro, 2003). Hispanics were also the least likely to be “very satisfied” with their current access to care (Zuvekas & Tallaferro, 2003).

A significant driver of Latino/non-Latino health care disparities is basic access to medical insurance (Le Cook, et al., 2009). Latino immigrants who are legal residents have a disproportionately high uninsurance rate (Harrell & Carrasquillo, 2003) and immigrant Latinos disproportionately lack health insurance and receive fewer health care services than US-born citizens (Rivers & Patino, 2006). Furthermore, there have been observed differences among the Hispanic ethnic subgroups. Latinos of Mexican descent see less health care access and utilization compared to non-Mexican Latinos (Bustamante, et al., 2009).

For low-income and uninsured patients, the Emergency Medical Treatment and Active Labor Act of 1986 (EMTALA) is of great consequence. EMTALA requires all hospitals that accept Medicare payment to provide emergency treatment to all persons, regardless of ability to pay. This law, however, may be more important to the Hispanic community. EMTALA also compels hospitals to provide emergency treatment regardless of citizenship or legal status. Approximately 76% of the 11 million undocumented immigrants in the United States are of Hispanic descent (Census Bureau, 2012; Pew Research Center, 2009).

Unalterable Characteristics and Ambulance Utilization

Demand for emergency services and emergency medicine is omnipresent throughout every community in The United States. There are, without much debate, certain demographic determinants of EMS demand that are translatable across jurisdictions and communities. Most evident are the findings that point to age and minority status as significant factors of EMS demand, finding that older individuals and minorities are disproportionate users of ambulance services (Cadigan & Bugarin, 1989; Rucker, et al., 1997; Clark & Fitzgerald, 1999; Clark, et al., 1999; Richards & Ferrall, 1999; Larkin, et al., 2006; Ruger, et al., 2006; Kawakami, et al., 2007). It follows an intuitive line of reasoning that as one grows older, the likelihood of experiencing an acute medical event increases, and therefore so does the probability of requiring emergency ambulance services.

Furthermore, race and socioeconomic status are notoriously difficult to disentangle. African-American patients, however, are more likely to utilize ambulance transport (Larkin, et al., 2006) and the lower one's socioeconomic status (measured through household income), the higher the likelihood of ambulance utilization (Rucker, et al., 1997; Kawakami, et al., 2007; Portz, et al., 2013). Additionally, although individual health status decreases with lower socioeconomic conditions, one's state of health is also inexorably tied to the community in which one lives.

Community median income and the percentage of the population living below the poverty level have been noted as factors of increased EMS demand (Cadigan & Bugarin, 1989). It has also been shown that property tax valuation can be effectively used as a proxy marker for mortality risk (Beale, et al., 2002) and that, for each $100,000 property value increment, the likelihood of receiving bystander CPR prior to EMS arrival increased[5] by 7% (Vaillancourt, et al., 2008; Mitchell, et al., 2009). Wealth and recent family income have also been noted as significant indicators of mortality risk (Duncan, et al., 2002), as was one's education level (Duncan, et al., 2002). Irrespective of income, one's health state has been shown to be connected to the community's socioeconomic status above and beyond the socioeconomic status of the individual (Robert, 1998) and that simply living in a poor community may be bad for one's health (Robert, 1999; Pickett & Pearl, 2001; Kawachi & Berkman, 2003). Other researchers have noted a negative accumulative effect on health for those living in high-poverty neighborhoods, with risk factors adding up over time and producing poor health (Kuh, et al., 2003; Ferraro & Shippee, 2008).

Although areas of lower socioeconomic status yield a higher EMS utilization rate, these areas also produce a higher concentration of high-acuity calls (Reinier, et al., 2006; Portz, et al., 2013). A study examining multiple measures of community-level socioeconomic conditions (median income, poverty level, median home value, and educational attainment) found that for each socioeconomic status measure, the incidence

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[5] Conversely, odds of cardiac arrest survival decreased 23% for each property value level. This is most likely due to EMS response times, which are typically shorter in impoverished areas and longer in affluent areas (Kleindorfer, et al., 2006).

of cardiac arrest was 30% to 80% higher in the lowest compared to the highest socioeconomic status quartiles (Reinier, et al., 2006). Additionally, Kawakami, et al. (2007) concluded that total EMS call volume is increased 10% to 20% by socioeconomic factors.

Gender has also been noted as a driver of ambulance utilization, with males being more likely to call for ambulance than females (Clark & Fitzgerald, 1999; Richards & Ferrall, 1999; Kawakami, et al., 2007; Meisel, et al., 2012). Frequent users of emergency ambulance services have been found to be male and African-American (Knowlton, et al., 2013). Men are also more likely to present with a greater severity of illness or injury (Kraus, et al., 1987; McConnell, et al., 1994; Gill & Riley, 1996) and are perceived by physicians to have an increased risk of death and disease (Schulman, et al., 1999; Roger, et al., 2000).

Conversely, Marinovich, et al. (2004) and Nagaraja, et al. (2012) found that women, not men, were higher users of emergency ambulance use. Additionally, Rucker, et al. (1997) found no difference in ambulance utilization between men and women. Other studies have not identified any differences between men and women (Ruger, et al., 2006; Patton & Thakore, 2012). These studies, however, have been limited in sample size and/or geographic variation (Ruger, et al., 2006; Nagaraja, et al., 2012; Patton & Thakore. 2012). Furthermore, some were composed of international populations (Marinovich, et al., 2004; Patton & Thakore, 2012).

Unalterable Characteristics and Patient Acuity

In addition to the effects that unalterable characteristics have on emergency ambulance utilization, there are also effects on patient acuity. Certain characteristics, such as age, gender, or race can increase the probability of serious illness or injury. Additionally, neighborhood-level determinants, such as socioeconomic status, have a positive effect on injury mortality rates (Cubbin, et al., 2000a; Cubbin, et al., 2000b).

Disparities also exist in regards to treatment between men and women in the ED. Researchers have found that men receive more exhaustive medical assessments (Armitage, et al., 1979), are more likely to be admitted to an in-patient unit (Selassie, et al., 2003), and receive more expensive and state-of-the-art medical interventions (Giacomini, 1996). Men who present to the ED with cardiac complaints are also more likely to receive cardiac testing (Schulman, et al., 1999; Pezzin, et al., 2007; Roger, et al., 2000) and subsequent invasive cardiac procedures (Ayanian, et al., 1991; Schulman, et al., 1999; Pezzin, et al., 2007; Roger, et al., 2000). Alternatively, women are perceived to experience more pain and are more likely to receive narcotic analgesia in the ED (Raferty, et al., 1995).

DATA & METHODOLOGY

Data from the National Hospital Ambulatory Medical Care Survey (NHAMCS), Emergency Department Edition, will be used. Due to public availability, data is used from years 2007–2010 (inclusive). Patient encounters in the ED are separated into sub-samples based on patient age, neighborhood poverty level, gender, race, and ethnicity. For analysis, logistic regression was employed. Average partial effects are then estimated and robust standard errors are utilized for inference. Of 136,147 total observations, 4,757 were missing transport mode and 15,239 were missing triage level or were not triaged. 120,908 observations were used for analysis (some observations missing both transport mode and triage level).

First, each observation within the dataset will be placed into an age-range category, with the age-range groups based on established classifications frequently employed in epidemiological and medical literature. Age groups consist of *less than 18 years, 18 to 24 years, 25 to 34 years, 35 to 44 years, 45 to 54 years, 55 to 64 years,* and *65 years or greater*. The analysis of the relationship between ambulance transport and the probability of diagnostic testing will be conducted for each age group separately.

Second, observations will be subset into four groups based upon the percentage of households below the federal poverty level within the patient's neighborhood[6]. The analysis of the relationship between ambulance transport and the probability of diagnostic testing will be conducted for each of the four poverty-level groups separately. This will allow me to identify any moderating effects of neighborhood poverty on the influence of an ambulance transport signal. The first group represents neighborhoods with less than

[6] "Neighborhood" is defined within the dataset by ZIP code.

5% poverty, the second group represents neighborhoods with 5%-9.99% poverty, the third group represents neighborhoods with 10%-19.99% poverty, and the fourth group represents neighborhoods with greater than 20% poverty.

Lastly, further examination of patient gender and race/ethnicity will also be explored. The analysis of the relationship between ambulance transport and the probability of diagnostic testing will be conducted for men and women separately and for racial/ethnic groups separately. Racial categories include *White, Black,* and *Other.* Ethnic categories include *Hispanic* and *Non-Hispanic*.

Dependent Variables

The dependent variables reflect specific diagnostic and imaging tests commonly used for the diagnosis of medical conditions (see Appendix A: Description of Diagnostic Tests). Within the NHAMCS data, nineteen diagnostic tests are available for inclusion and are measured dichotomously. Fifteen tests will be included in the final analysis (refer to Table 1). The diagnostic tests that will not be included in the final analysis are either uncommon (blood alcohol content, toxicology screening) or overly commonplace (flu test, pregnancy test) resulting in very little variation within the sample. One imaging test (MRI) will be analyzed despite its low-frequency use. Its inclusion is due to the test's high cost and use of highly specialized equipment.

35,517 (29.4%) of patients received no diagnostic or imaging services. The provision of diagnostic testing was chosen as a measure due to its timing in the patient-physician interaction sequence. It is posited that shifts in physician behavior, due to patient signals, can be effectively measured through observed disparities in diagnostic provisions between ambulance and non-ambulance patients.

TABLE 1: Diagnostic services and frequency of provision

Abbreviation	Description	Patients Receiving Test	EMS Arrival	Non-EMS	Unk
CBC	Complete Blood Count	45,171 (37%)	12,648 (28%)	31,283 (69%)	1,240 (3%)
BUN	Blood Urea Nitrogen	31,070 (26%)	9,320 (30%)	20,977 (68%)	773 (3%)
ENZYMES	Cardiac Enzymes	17,137 (14%)	6,092 (36%)	10,591 (62%)	454 (3%)
ELECTROLYTES	Electrolytes	27,600 (23%)	8,415 (31%)	18,434 (67%)	751 (3%)
BGL	Blood Glucose Level	28,527 (24%)	8,745 (31%)	19,090 (67%)	692 (2%)
LFT	Liver Function Test	12,422 (10%)	3,770 (30%)	8,359 (67%)	293 (2%)
ABG	Arterial Blood Gas	4,571 (4%)	1,869 (41%)	2,600 (57%)	102 (2%)
PT/INR	Prothrombin Time	10,192 (8%)	3,813 (37%)	6,063 (60%)	316 (3%)
BCULTURES	Blood Cultures	6,188 (5%)	2,159 (35%)	3,842 (62%)	187 (3%)
MONITOR	Cardiac Monitoring	10,879 (9%)	4,683 (43%)	5,925 (55%)	271 (3%)
EKG	12-Lead Electrocardiogram	22,020 (18%)	8,312 (38%)	13,128 (60%)	580 (3%)
URINE	Urine Analysis	29,499 (24%)	7,136 (24%)	21,594 (73%)	769 (3%)
XRAY	X-Ray (Any Body Part)	42,149 (35%)	10,497 (25%)	30,530 (72%)	1,122 (3%)
CAT	CAT Scan (Any Body Part)	17,792 (15%)	5,846 (33%)	11,521 (65%)	425 (2%)
MRI	MRI (Any Body Part)	779 (1%)	226 (29%)	529 (68%)	24 (3%)
NONE	No Diagnostic Services	35,517 (29%)	1,517 (4%)	33,003 (93%)	997 (3%)

Independent Variable

The key explanatory variable for this section is patient arrival to the emergency department via ambulance, measured dichotomously. The "ambulance" mode of arrival includes patients arriving to the emergency department via air or ground units and includes both Advanced Life Support and Basic Life Support ambulance units. The non-ambulance designation denotes any non-ambulance means of transport and includes private vehicle, taxi, public transportation, walk-in, and other.

Control Variables

Except where subset data creates redundancy, control variables include patient's age measured in years, gender (male or female), race (White, Black, or Other), and ethnicity (Hispanic or non-Hispanic). Adjustments for patient insurance status include private payer, Medicare, Medicaid, Worker's Compensation coverage, self-pay, and other. Controls for neighborhood poverty level are categorized into four levels based upon the percentage of residents in the patient's ZIP code living below the Federal Poverty Level. Poverty categories include less than 5%, 5% to 9.99%, 10% to 19.99%, and 20% or greater, The patient's residential status is taken into account and includes private home, nursing home, other residence, other institution, and homeless.

Emergency department wait-time is also controlled for and is measured continuously in minutes from arrival to physician contact, as is the patient's triage category (priority 1 through 5). The subsequent hospital admission decision for each patient is included and measured dichotomously (admitted to in-patient nursing unit or discharged from the ED). Other controls include the U.S. region in which the treating hospital is located (northeast, midwest, south, and west), whether the treating hospital is located in a metropolitan statistical area (measured dichotomously), ownership status of treating hospital (non-profit, for-profit, and non-federal public), and year fixed-effects.

Expected Results

Patient subgroups based on non-adjustable characteristics are expected to affect the ambulance signal in varying directions and magnitudes. Based on existing literature, Table 2 summarizes the expected effects on the ambulance signal as it relates to diagnostic service provisions. Compared to baseline, the ambulance signal is expected to be enhanced as age increases, neighborhood poverty level increases, and when a patient is male, White, or non-Hispanic. Conversely, the ambulance signal is expected to be mediated as age decreases, neighborhood poverty level decreases, and when the patient is female, Black or Other-race, or Hispanic. Academic literature is provided for each demographic characteristic with the exception of age. It is common knowledge that health decreases as one ages. Therefore, it follows that emergency physicians would more readily assume older patients to be in poor health.

TABLE 2: Expected findings of non-adjustable signals on diagnostic provision (as compared to baseline)

	Expected Finding	Citations
AGE	↓ < 18 ↓ 18-24 ↓ 25-34 ≈ 35-44 ↑45-54 ↑ 55-64 ↑ 65+	
POVERTY	↓ < 5% ↓ 5% - 9.99% ↑ 10% - 19.99% ↑ 20%+	Cadigan & Bugarin, 1989; Weissman, et al., 1991; Bindman, et al., 1995; Rucker, et al., 1997; Ayanian, et al., 2000 Baker, et al., 2000; Fiscella, et al., 2000a Reinier, et al., 2006; Kawakami, et al., 2007; Vaillancourt, et al., 2008; Mitchell, et al., 2009; Portz, et al., 2013
SEX	↑ Male ↓ Female	Armitage, et al., 1979; Ayanian, et al., 1991; Giacomini, 1996; Clark & Fitzgerald, 1999; Richards & Ferrall, 1999; Schulman, et al., 1999; Roger, et al., 2000; Selassie, et al., 2003; Kawakami, et al., 2007; Pezzin, et al., 2007; Meisel, et al., 2012
RACE	↑ White ↓ Black ↓ Other	Gerbert, 1984; Giacomini, 1996; Van Ryn & Burke, 2000; Larkin, et al., 2006
ETHNICITY	↓ Hispanic ↑ Non-Hispanic	Harrell and Carrasquillo, 2003; Zuvekas & Tallaferro, 2003; Rivers & Patino, 2006; Bustamante, et al., 2009; Le Cook, et al., 2009; Bustamante, et al., 2010

RESULTS

Prior to data analysis, the expected results are that the ambulance signal is expected to be enhanced as age increases, neighborhood poverty level increases, and when a patient is male, White, or non-Hispanic. Conversely, the ambulance signal is expected to be mediated as age decreases, neighborhood poverty level decreases, and when the patient is female, Black or Other-race, or Hispanic.

The largest age group in the sample was children less than 18 years of age, who comprised of 23% of all patients (Table 3). The smallest age group was those aged 55 to 64 years (9%). All other age categories represented 12% to 15% of all patients. The lowest neighborhood poverty category (less than 5%) consisted of 14% of all patients while the highest neighborhood poverty level was represented by 22% of all patients. The largest poverty group was those patients from neighborhoods in the 10% to 19.99% poverty level group (34% of patients).

Female patients were the most common, consisting of 54% of all patients (Table 3). White patients were the most frequent (71%), followed by Black patients (24%). Hispanic patients consisted of 15% of all patients. Demographics reported by the U.S. Census Bureau show the total population consists of 51% female, 77% White, 13% Black, 17% Hispanic.

Excluding the age subgroups, frequency of ambulance arrival to the ED was fairly consistent across the subcategories, ranging from 23% to 27% (Table 3). The largest variation in frequency of EMS arrival was noted in the age categories. Children less than 18 years of age were the least likely to arrive via ambulance (9%) while those aged 65 years or greater were the most likely to arrive by ambulance (57%). Frequency of ambulance utilization also increased as each age-range grew older, as was expected. For observations that were missing mode of arrival, there was no noticeable pattern of missing data across subgroups. Missing arrival mode was approximately 3% to 4% in each subgroup category.

TABLE 3: Patient mix by subset categories and EMS transport rate

Variable	N	EMS Arrival	Non-EMS	Unk
AGE				
<18	30,686 (23%)	2,889 (9%)	26,786 (87%)	1,011 (3%)
18-24	16,736 (12%)	2,970 (18%)	13,187 (79%)	579 (4%)
25-34	20,915 (15%)	3,527 (17%)	16,646 (80%)	742 (4%)
35-44	18,177 (13%)	4,062 (22%)	13,447 (74%)	668 (4%)
45-54	17,702 (13%)	4,925 (28%)	12,136 (69%)	641 (4%)
55-64	11,763 (9%)	4,055 (35%)	7,302 (62%)	406 (4%)
65-over	20,168 (15%)	11,581 (57%)	7,877 (39%)	710 (4%)
POVERTY				
< 5%	18,655 (14%)	4,722 (25%)	13,271 (71%)	662 (4%)
5% - 9.99%	33,309 (25%)	8,139 (24%)	24,136 (73%)	1,034 (3%)
10% - 19.99%	46,331 (34%)	10,713 (23%)	34,120 (74%)	1,498 (3%)
> 20%	30,497 (22%)	8,356 (27%)	20,984 (69%)	1,157 (4%)
Missing	7,355 (5%)	2,079 (28%)	4,870 (66%)	406 (6%)
SEX				
Female	73,665 (54%)	18,014 (25%)	53,132 (72%)	2,519 (3%)
Male	62,482 (46%)	15,995 (26%)	44,249 (71%)	2,238 (4%)
RACE				
White	96,900 (71%)	24,208 (25%)	69,480 (72%)	3,212 (3%)
Black	32,532 (24%)	8,101 (25%)	23,089 (71%)	1,342 (4%)
Other	6,715 (5%)	1,700 (25%)	4,812 (72%)	203 (3%)
ETHNICITY				
Hispanic	19,790 (15%)	4,390 (22%)	14,695 (74%)	705 (4%)
Non-Hispanic	116,357 (86%)	29,619 (26%)	82,686 (71%)	4,052 (4%)

Table 4 presents the average partial effects of ambulance transport by each age range. Findings indicate that arrival to the ED via emergency ambulance is associated with an increased likelihood of diagnostic testing across all age groups. Also, the effect of ambulance transport on the provision of diagnostic services is influenced by patient age. Overall, the trend indicates that the power of the ambulance signal is amplified as one grows older, then diminishes a small amount once reaches the 65 and older group. This finding may be explained by the routine use of diagnostic services for this subgroup. For all patients aged 65 or older, only 12% (2,122 patients) received no diagnostic services during their ED visit while 57% utilized ambulance transport. Thus, the usefulness of the ambulance signal is somewhat muted in this context as the patient is likely to receive diagnostic services regardless of arrival mode. Considerable differences between the oldest age group (65 years or older) and the next closest group (55 to 64 years) were seen with CBC, BUN, Cardiac Enzymes, Electrolytes, LFT, and PT/INR tests.

TABLE 4: Adjusted[A] average partial effects of ambulance transport on diagnostic services by age range

Variable	All Patients	< 18	18-24	25-34	35-44
CBC	0.0804***	0.0503***	0.0948***	0.1079***	0.1040***
BUN	0.0539***	0.0302***	0.0576**	0.0837***	0.0589**
ENZYMES	0.0311***	0.0141***	0.0240*	0.0323*	0.0411*
ELECTROLYTES	0.0473***	0.0388***	0.0487**	0.1056***	0.0505**
BGL	0.0571***	0.0413***	0.0859***	0.1038***	0.0712***
LFT	0.0178***	0.0096**	0.0105	0.0353*	0.0224
ABG	0.0136***	0.0069***	0.0161*	0.0150*	0.0270**
PT/INR	0.0185***	0.0076***	0.0226**	0.0418***	0.0286*
CULTURES	0.0061***	0.0023	0.0093	0.0099	0.0126
MONITOR	0.0483***	0.0314***	0.0503***	0.0675***	0.0600***
EKG	0.0752***	0.0303***	0.0740***	0.0802***	0.0952***
URINE	0.0334***	0.0214**	0.0193	0.0352	0.0410+
XRAY	0.0886***	0.0508***	0.0779***	0.1154***	0.0917***
CATSCAN	0.0853***	0.0798***	0.1198***	0.1148***	0.1021***
MRI	0.0013*	0.0035*	0.0019	0.0061	0.0011
	All Patients	**45-54**	**55-64**	**> 64**	
CBC	0.0804***	0.0973***	0.1498***	0.0679***	
BUN	0.0539***	0.0592**	0.1148***	0.0510***	
ENZYMES	0.0311***	0.0276	0.0991***	0.0452***	
ELECTROLYTES	0.0473***	0.0569**	0.0995***	0.0378***	
BGL	0.0571***	0.0676**	0.1066***	0.0532***	
LFT	0.0178***	0.0083	0.0601**	0.0166*	
ABG	0.0136***	0.0170+	0.0411**	0.0196***	
PT/INR	0.0185***	0.0409**	0.0691***	0.0181**	
CULTURES	0.0061***	0.0021	0.0013	0.0095+	
MONITOR	0.0483***	0.0411*	0.0897***	0.0758***	
EKG	0.0752***	0.1079***	0.1436***	0.1106***	
URINE	0.0334***	0.0528*	0.0407+	0.0455***	
XRAY	0.0886***	0.1086***	0.0850**	0.0793***	
CATSCAN	0.0853***	0.1070***	0.0927***	0.0873***	
MRI	0.0013*	0.0046	0.0022	0.0006	

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

[A] Adjusted for gender, race, ethnicity, triage category, wait time, region, ownership type, MSA, insurance type, poverty level, primary residence, and year fixed-effects.

Table 5 presents the average partial effects of ambulance transport by each neighborhood poverty range. Findings indicate that arrival to the ED via emergency ambulance is associated with an increased likelihood of diagnostic testing across all poverty ranges. The effect of ambulance transport on the provision of diagnostic services is influenced by neighborhood poverty. Ambulance patients in the lowest poverty subgroup (less than 5% neighborhood poverty) were found to have a lower level of increased likelihood of diagnostic services, compared to all patients, for 13 of 15 services. The largest differences between all ambulance patients and poverty level were observed in the third neighborhood poverty subgroup (10% to 19.99% poverty). Ambulance patients in this group saw a 10.4 percentage point increase in the likelihood of CBC testing while all patients saw a 8 percentage point increase in likelihood of receiving the test. Overall, the trend indicates that the power of the ambulance signal is amplified as one arrives from a higher-poverty neighborhood, and then diminishes a small amount once one reaches the most impoverished group.

TABLE 5: Adjusted[A] average partial effects of ambulance transport on diagnostic services by neighborhood poverty

Variable	All Patients	< 5%	5% - 9.99%	10% - 19.99%	> 20%
CBC	0.0804***	0.0591***	0.0714***	0.1037***	0.0780***
BUN	0.0539***	0.0335***	0.0509***	0.0695***	0.0525***
ENZYMES	0.0311***	0.0176**	0.0293***	0.0325***	0.0362***
ELECTROLYTES	0.0473***	0.0253**	0.0455***	0.0555***	0.0544***
BGL	0.0571***	0.0354***	0.0513***	0.0723***	0.0600***
LFT	0.0178***	0.0122+	0.0140**	0.0206***	0.0231***
ABG	0.0136***	0.0086**	0.0113***	0.0187***	0.0103**
PT/INR	0.0185***	0.0100+	0.0166***	0.0213***	0.0208***
CULTURES	0.0061***	-0.0074*	0.0010	0.0133***	0.00874**
MONITOR	0.0483***	0.0472***	0.0579***	0.0485***	0.0369***
EKG	0.0752***	0.0859***	0.0780***	0.0724***	0.0650***
URINE	0.0334***	0.0224*	0.0353***	0.0368***	0.0335***
XRAY	0.0886***	0.0878***	0.1048***	0.0904***	0.0718***
CATSCAN	0.0853***	0.0893***	0.0905***	0.0841***	0.0776***
MRI	0.0013*	0.0028	-0.0001	0.0021+	0.0019

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

[A] Adjusted for gender, race, ethnicity, age, triage category, wait time, region, ownership type, MSA, insurance type, primary residence, and year fixed-effects.

Table 6 presents the average partial effects of ambulance transport by patient gender. Findings indicate that arrival to the ED via emergency ambulance is associated with an increased likelihood of diagnostic testing across gender groups. The effect of ambulance transport on the provision of diagnostic services is influenced by gender. Male gender is found to have a positive effect on the initial ambulance signal in regards to the provision of diagnostic services. For example, for all patients, ambulance arrival results in an 8 percentage point increase in the likelihood of CBC testing. For male patients, however, ambulance transport results in a 9.3 percentage point increase in the likelihood of CBC testing. Compared to women, male patients see an increased likelihood across all diagnostic services, except for ABG and X-Ray.

TABLE 6: Adjusted[A] average partial effects of ambulance transport on diagnostic Services by Gender

Variable	All Patients	Male	Female
CBC	0.0804***	0.0929***	0.0683***
BUN	0.0539***	0.0652***	0.0433***
ENZYMES	0.0311***	0.0365***	0.0267***
ELECTROLYTES	0.0473***	0.0546***	0.0404***
BGL	0.0571***	0.0657***	0.0490***
LFT	0.0178***	0.0208***	0.0152***
ABG	0.0136***	0.0132***	0.0140***
PT/INR	0.0185***	0.0190***	0.0180***
CULTURES	0.0061***	0.0049**	0.0075***
MONITOR	0.0483***	0.0542***	0.0426***
EKG	0.0752***	0.0819***	0.0691***
URINE	0.0334***	0.0370***	0.0299***
XRAY	0.0886***	0.0776***	0.0963***
CATSCAN	0.0853***	0.1048***	0.0673***
MRI	0.0013*	0.0021**	0.0008

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10
[A] Adjusted for race, ethnicity, age, triage category, wait time, region, ownership type, MSA, insurance type, poverty level, primary residence, and year fixed-effects.

Table 7 presents the average partial effects of ambulance transport by race. Findings indicate that arrival to the ED via emergency ambulance is associated with an increased likelihood of diagnostic testing across all race groups. The effect of ambulance transport on the provision of diagnostic services is influenced by patient race. Compared to all patients, White ambulance patients were found to have a smaller likelihood of receiving 10 of the 15 services. 8 of 15 diagnostic services saw an increase in likelihood of provision for Black patients. 12 of 15 diagnostic services were noted to increase for *Other* patients.

From baseline, the largest increases in likelihood of diagnostic provision were observed in the *Other* subgroup. While all ambulance patients had an 8 percentage point increase in the likelihood of CBC testing, *Other* ambulance patients had a 9.1 percentage point increase in the likelihood of receiving the test. Furthermore, *Other* ambulance patients saw a 6.4 percentage point increase in the likelihood of cardiac enzyme testing while all ambulance patients had a 3.1 percentage point increase.

TABLE 7: Adjusted[A] average partial effects of ambulance transport on diagnostic services by race

Variable	All Patients	White	Black	Other
CBC	0.0804***	0.0818***	0.0745***	0.0909***
BUN	0.0539***	0.0515***	0.0595***	0.0675***
ENZYMES	0.0311***	0.0274***	0.0360***	0.0635***
ELECTROLYTES	0.0473***	0.0423***	0.0593***	0.0642***
BGL	0.0571***	0.0522***	0.0672***	0.0847***
LFT	0.0178***	0.0158***	0.0234***	0.0232*
ABG	0.0136***	0.0139***	0.0121***	0.0217**
PT/INR	0.0185***	0.0163***	0.0236***	0.0321***
CULTURES	0.0061***	0.0040*	0.0112***	0.0119
MONITOR	0.0483***	0.0510***	0.0409***	0.0525***
EKG	0.0752***	0.0769***	0.0672***	0.0959***
URINE	0.0334***	0.0360***	0.0302***	0.0136
XRAY	0.0886***	0.0864***	0.0913***	0.1072***
CATSCAN	0.0853***	0.0851***	0.0807***	0.1095***
MRI	0.0013*	0.0021*	-0.0008	0.0016

*** $p<0.001$, ** $p<0.01$, * $p<0.05$, + $p<0.10$

[A] Adjusted for gender, ethnicity, age, triage category, wait time, region, ownership type, MSA, insurance type, poverty level, primary residence, and year fixed-effects.

Table 8 presents the average partial effects of ambulance transport by ethnicity. Findings indicate that arrival to the ED via emergency ambulance is associated with an increased likelihood of diagnostic testing across ethnicity groups. The effect of ambulance transport on the provision of diagnostic services is influenced by patient ethnicity. Hispanic ambulance patients were observed to have a smaller likelihood of diagnostic testing, compared to all patients, in 11 of 15 services. Hispanic ambulance patients saw a 6.4 percentage point increase in the likelihood of CBC testing while all ambulance patients had a 8 percentage point increase. Additionally, Hispanic ambulance patients were found to have a 2.9 percentage point increase in the likelihood of blood glucose testing while all ambulance patients saw a 5.7 percentage point increase in the likelihood of blood glucose testing.

TABLE 8: Adjusted[A] average partial Effects of ambulance transport on diagnostic services by ethnicity

Variable	All Patients	Hispanic	Non-Hispanic
CBC	0.0804***	0.0641***	0.0829***
BUN	0.0539***	0.0268***	0.0583***
ENZYMES	0.0311***	0.0220***	0.0327***
ELECTROLYTES	0.0473***	0.0169*	0.0526***
BGL	0.0571***	0.0291***	0.0617***
LFT	0.0178***	0.0155*	0.0181***
ABG	0.0136***	0.0147***	0.0134***
PT/INR	0.0185***	0.0203***	0.0181***
CULTURES	0.0061***	0.0119**	0.0050**
MONITOR	0.0483***	0.0378***	0.0496***
EKG	0.0752***	0.0587***	0.0778***
URINE	0.0334***	0.0163+	0.0361***
XRAY	0.0886***	0.0674***	0.0923***
CATSCAN	0.0853***	0.0875***	0.0844***
MRI	0.0013*	0.0032+	0.0011

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

[A] Adjusted for gender, race, age, triage category, wait time, region, ownership type, MSA, insurance type, poverty level, primary residence, and year fixed-effects.

DISCUSSION

Michael Spence's theory of signaling concerns both adjustable and non-adjustable characteristics. After examining the effects of non-adjustable characteristics (age, gender, race, ethnicity, and neighborhood poverty) on the provision of diagnostic services, each subgroup was found to mediate or enhance the adjustable ambulance signal. Analysis revealed that being male, non-Hispanic, *Other*-race, age 55 to 64, or living in moderately impoverished neighborhoods (10% to 19.99% poverty) had the most enhanced effect on the ambulance signal in regards to the provision of diagnostic services. Conversely, being female, Hispanic, White, aged less than 18, or living in low-poverty neighborhoods (less than 5% poverty) was found to diminish the effect of the ambulance signal on the provision of diagnostic services.

These findings are fairly consistent with the initial expectations of signal effect modification. Being male, non-Hispanic, age 55 to 64, and patients from impoverished neighborhoods were expected to increase the effect of the ambulance signal on the provision of diagnostic services in the ED. Contrary to the expected findings, however, being White decreased the ambulance signal while being Black or Other-race increased the signal. Additionally,

The subgroup reflecting the *65 and Older* age-range deviated somewhat from the initial projections. The most considerable differences in signal modification between the *55 to 64* and *65 and Older* groups were observed with the provisions of CBC, Electrolyte, BUN, Cardiac Enzymes, PT/INR, and LFT testing. While CBC and Electrolyte testing is commonplace, the *65 and Older* group may be more likely to have cardiac complaints or underlying issues necessitating a more pervasive use of BUN, Cardiac Enzymes, and

PT/INR testing. Ubiquitous LFT testing may speak to polypharmacy issues associated with the Medicare population.

Additionally, and as expected, the ambulance signal was the weakest for patients under the age of 18. Unless beset by pre-existing and complicated disease processes, children do not suffer from the chronic illnesses typically associated with advanced age. Thus, any child presenting to the ED may be viewed as acute, regardless of arrival mode. Children may also enjoy the advantage of an additional advocate (parent or guardian) as a health care decision-maker, mediating the effect of the ambulance signal.

Ambulance signal modification deviated from the initial prediction in the highest-poverty group. Although the decrease in signal modification is slight from the *10% to 19.99%* group to the *>20%* group, it is difficult to determine why a decrease in signal power is noted. Perhaps, though, hospitals that serve the most impoverished neighborhoods provide medical care *primarily* to the most impoverished. Public hospitals, such as the famous (and now vacant) Charity Hospital in New Orleans, Louisiana, typically bear the burden of uncompensated charity care and serve the poorest of the poor. Thus, variation in this sample may be low for *>20%* group. When compared to private non-profit hospitals, the Agency for Healthcare Research and Quality found that public hospitals served more Medicaid or uninsured patients (33% versus 22%) and in-patient stays at public hospitals were more likely to be for patients from low-income neighborhoods (35% versus 26%) (Fraze, et al., 2010). Additionally, these low-income patients may also a lower level of care regardless of arrival mode. Compared to private non-profit hospitals, only 28% of public hospitals employed hospitalist physicians on staff, while 50% of non-profit hospitals employed physicians with this specialty (Fraze, et al., 2010). Public hospitals are also less likely to provide services associated with high cost and technology such as intensive care units (ICU), cardiac surgery, trauma care, and MRI (Fraze, et al., 2010).

Being female had a stronger effect on the ambulance signal than was being male in regards to X-Ray imaging. This finding may be influenced by the increased likelihood of osteoporosis and calcium deficiencies in the female population, thereby increasing the risk of orthopedic injury. Women who arrived by emergency ambulance were also found to be slightly more likely than men to receive ABG and Blood Culture testing.

The minority racial groups, *Black* and *Other*, had a larger effect on the ambulance signal than did the *White* group. This finding is contrary to the initial predictions. We may be observing this pattern due to simple self-advocacy in the medical setting. White and more affluent patients are often more likely to request specific medical services from their physician rather than acquiescing to the physician's proposed course of action (Cooper-Patrick, et al., 1999; Blanchard & Lurie, 2004; Wiltshire, et al., 2006) and African-American men are less likely to tell their physician of outside medical information that has been sought (Elder, et al., 2010). Thus, the ambulance signal for the *White* group may be mitigated by an increase in diagnostic demand from non-ambulance patients.

Non-Hispanic patients were seen to have a larger ambulance signal than Hispanic patients. This finding is consistent with the initial predication and explained by previous literature. This study, however, is limited in that the data are unable to differentiate between Hispanic subgroups, such as Mexican Latinos and non-Mexican Latinos. These distinctions have been made in past literature and may be beneficial for future lines of research.

The utilization of emergency ambulance transport to the ED increases one's probability of receiving diagnostic and imaging services. This finding persists when unalterable characteristics are examined. While all of the subgroups in this study enjoy a positive effect from ambulance arrival to the ED, ambulance transport is a stronger signal for some groups than for others. As previously predicted, the signal from ambulance transport for non-Hispanic males is larger than the signal for their Hispanic counterparts. Contrary to the predictions, however, white patients, the most destitute, and those age 65 or greater do not experience the strongest ambulance signal. Instead, both *Black* and *Other* patients surpass *White* patients while the penultimate groups for age and poverty have the strongest effect on the ambulance transport signal.

CONCLUSION

For this dissertation, both emergency ambulance and emergency department data were analyzed. Utilizing organizational ownership as an explanatory variable, the probability of engaging in patient transport was explored using data collected by the Virginia Office of EMS for the years 2009 – 2013 (inclusive). Next, utilizing hospital emergency department data from the Centers for Disease Control and Prevention, I examined the likelihood of receiving diagnostic services for patients arriving to the ED via ambulance. Lastly, I continued analysis of the hospital emergency department data for the purpose of identifying differences in the magnitude of the ambulance effect on the probability of receiving diagnostic services for distinct demographic subgroups of ED patients.

The findings of this dissertation have yielded three major conclusions. These conclusions maintain both statistical and practical significance.

1. The probability of engaging in patient transport is higher for private EMS agencies when compared to their publicly owned counterparts. There also exists a difference in the probability of transport between private non-profit and private for-profit organizations, with for-profit organizations exhibiting the highest likelihood of patient transport.
2. Ambulance patients are more likely to receive diagnostic services in the ED than otherwise similar non-ambulance patients. There was also an observed inverse relationship between the probability of ambulance patients receiving services and their medical acuity level.
3. Upon further examination of the ambulance signal, certain demographic groups either enhance or mediate the signal's effect. While all groups are more likely to receive diagnostic services when arriving by ambulance, some groups derive more value from the ambulance signal.

Utilizing organizational ownership as a causal variable in relation to patient transport decisions, results have shown that privately owned EMS agencies are more likely to engage in transport than their publicly owned equivalents. Organizational composition has remained overlooked as an explanatory mechanism for unnecessary ambulance transport and has now been shown to be of significant consequence. There also exists a difference in the probability of transport between private non-profit and private for-profit organizations. Non-profit agencies are 11.6 percentage points more likely than fire department agencies to transport while for-profit agencies are 16.9 percentage points more likely. These findings support the hypothesis that disparities among ownership types concerning patient transport decisions exist and are attributable to financial incentives, with privately funded organizations being the most likely to engage in patient transport.

With a greater emphasis on the difference between revenue and cost, private EMS agencies appear to favor patient transport when compared to their public peers. These findings support the notion that private EMS organizations respond to market incentives that encourage costly transport. Economic theory suggests that private non-profit agencies behave similarly to for-profit organizations up until a budget-constraint break-even point (Newhouse, 1970). This idea explains the finding that private for-profit EMS agencies are more likely to transport a patient than are private non-profit EMS organizations.

Once the patient is transported, he will enter the hospital system through the ED. Findings show a positive ambulance effect on the probability of receiving diagnostic services with an inverse relationship to the patient's medical acuity. For example, ambulance patients in the *Immediate* triage category were 5.6 percentage points more likely than non-ambulance patients to receive CBC testing while those arriving by ambulance in the > *2hours* category were 14.3 percentage points more likely to receive the test. Analysis supports the hypothesis that emergency department physicians readily accept ambulance transport as a valid signal of patient acuity, regardless of true medical acuity level. The physician may be more likely to cast a much wider diagnostic net for an ambulance patient with the subconscious belief that this patient has more hidden medical conditions than does his non-ambulance counterpart. Consequently, patients transported to the hospital via ambulance may be receiving a disproportionate amount of medical resources.

Michael Spence's (1973) view of signaling in the presence of asymmetric information is directly applicable to this step of the emergency care continuum. Patients often present to the emergency department physician with subjective, vague, or incomplete personal complaints. During the initial meeting, the physician must draw upon as many objective medical findings as possible before moving forward with a diagnostic plan. The physician uses available data to help determine which tests and services will be the most beneficial for symptom diagnosis and treatment. Findings such as patient presentation (skin condition or work-of-breathing) and vital signs can help guide the physician. As it relates to diagnostic provision, arrival to the ED by emergency ambulance is now argued to be an important variable during this early junction in the medical process.

The ambulance signal, however, does not affect the probability of receiving diagnostic services for every patient in an equal fashion. Just as the patient population is heterogeneous, so to are the effects of the ambulance signal. After examining the effects of the ambulance signal on the provision of diagnostic services using homogeneous patient groups based upon non-adjustable characteristics (age, gender, race, ethnicity, and neighborhood poverty), each subgroup was found to either mediate or enhance the ambulance signal. Analysis revealed that being male, non-Hispanic, *Other*-race, age 55 to 64, or living in moderately impoverished neighborhoods (10% to 19.99% poverty) had the most enhanced effect on the ambulance signal in regards to the provision of diagnostic services. Conversely, being female, Hispanic, White, aged less than 18, or living in low-poverty neighborhoods (less than 5% poverty) was found to diminish the power of the ambulance signal on the provision of diagnostic services.

When arriving to the ED via ambulance, being male produces a 9.3 percentage point increase in the likelihood of receiving CBC testing as compared to arriving by other means, while being female increases the likelihood by 6.8 percentage points. Non-Hispanic ambulance patients are 8.3 percentage points more likely to receive CBC testing than their non-ambulance counterparts, and Hispanic patients are 6.4 percentage points more likely. Additionally, being an ambulance patient aged 55 years to 64 years increases one's likelihood of receiving CBC testing by 15 percentage points (as compared to non-ambulance patients of the same age), while those aged less than 18 years see a 5 percentage point increase in probability. Ambulance patients living in neighborhoods with 10% to 19.99% poverty levels have a 10.4 percentage point increase in the likelihood of receiving CBC testing as compared to arriving by other means, and ambulance patients who live in neighborhoods with less than 5% poverty have a 5.9 percentage point increase in probability.

Policy Implications

Medical insurers have clear conditions for reimbursement of emergency ambulance services. Currently, patient transport is the most common service for which EMS agencies can bill. The Centers for Medicare and Medicaid Services (CMS) limits reimbursement to transport only and private insurers have largely copied this practice. This restrictive reimbursement policy, duplicated by private insurers (regardless of patient age), may be distorting EMS agency behavior by incentivizing transport to the hospital, whether medically appropriate or not.

This untoward effect may have two large consequences. First, on a local-level, individual jurisdictions choose with whom they will contract for EMS coverage. By contracting with a private EMS agency, local bureaucrats and politicians may be unintentionally shifting a higher burden of cost onto the community. Analysis has found that, given similar populations, private EMS organizations will engage in transport more often. This not only affects individual finances in regards to billing and medical insurance deductibles but would also place a heavier load on local hospitals. A higher patient census in the emergency department stresses available resources and ultimately puts patient safety at risk (Trzeciak & Rivers, 2003).

Second, on a macro-level, Medicare policy concerning emergency ambulance services is both outdated and inefficient. Although the American EMS system has evolved over the past 40 years into a robust and highly capable medical delivery system, federal reimbursement policy has not evolved alongside it. CMS has classified ambulance reimbursement as a “transportation benefit” and has never revisited the operational definition.

Upon Medicare's introduction in 1965, EMS was a simple emergency transportation system with very little pre-hospital medical treatment. The patient was placed into the vehicle (typically a retrofitted hearse) and quickly driven to the hospital. In the subsequent decades, EMS has grown to incorporate high educational standards and the capability to provide advanced medical care in the pre-hospital setting (thus negating the need for transport in many cases). CMS, however, has not followed suit and the current reimbursement policy is not consistent with the modern landscape in which EMS now operates.

By incentivizing patient transport, there may be a misallocation of reimbursement funds. In Virginia alone, simple calculations showed that, in the emergency setting, CMS could be reimbursing approximately $5 million per year for unnecessary transport of Medicare beneficiaries. This money could easily be re-allocated and utilized in such a way as to provide payment for EMS on-scene assessment and treatment without subsequent transport.

The incentives towards unnecessary emergency ambulance transport do not end at the ED doors, however. In an environment that stresses resource management and fiscal prudence, emergency physicians appear to exhibit a bias towards ambulance patients in regards to diagnostic provisions. Thus, for patients interested in more extensive diagnostic services, it is in one's best interest to present oneself to the ED via ambulance regardless of medical necessity. This perverse incentive may lead to a strain on the pre-hospital emergency system and the potential excessive use of diagnostic resources within the ED.

Alternative destinations for EMS should be explored. Currently, emergency departments are the sole recipients of EMS patients. Not all patients who summon an emergency ambulance, however, require ED-level hospital care. Many patients can be effectively assessed and treated at facilities such as an urgent care, medical clinic, or mental health facility. Alternative destinations would lessen the burden on ED workload while substantially decreasing the use of diagnostic services. Analysis revealed that low acuity patients benefit the most from the ambulance signal. Since it is these patients that would be the most likely to be triaged towards an alternative destination, expensive diagnostic services could be more efficiently allocated.

Furthermore, medical insurance reimbursement for non-transport decisions should be introduced. Although denial-of-transport protocols have proven themselves complicated and problematic from a legal liability standpoint[7], EMS agencies would benefit from improved reimbursement policies that incorporate non-transport options. By reimbursing costs related to on-scene treatment and medical assessment of a patient, EMS organizations would not have to rely on patient transport as their primary source of revenue. Non-transport would potentially most benefit the least acute patients. This subset of patients could be adequately treated in the pre-hospital setting without exposing them to the financial burden of high medical bills or to the possibility of acquiring a nosocomial infection while in the hospital's ED.

There are many opportunities for future research in this area, using both quantitative and qualitative methods. Analysis of organizational ownership as a driver of

[7] Denial-of-transport protocols allow paramedics to actively deny ambulance transport to a patient under certain circumstances. Wake County (North Carolina) terminated its protocol after finding that the rigid conditions required for such a protocol resulted in less than 1% of patients eligible for the protocol. Of those eligible to be denied transport, many were still transported due to paramedic discretion.

patient transport can be expanded to include varying geographic regions. Different states employ varying proportions of public and private EMS agencies. Therefore, the findings of this dissertation can be tested while increasing external validity. Additionally, interviews and conversations with both governmental leaders and EMS administrators may add a layer of depth to the discussion of EMS ownership.

There is also may be an opportunity to blind the emergency physician to the mode of arrival in an effort to diminish bias in diagnostic provisioning. Analysis revealed that the power of the ambulance signal was greatest for the least acute patients. Therefore, it would be feasible to conceal the arrival mode in many cases. It would not be possible to keep the arrival mode unknown for the most acute of patients, but the effect of the ambulance signal for this subset of patients was found to be negligible. Here again, focused interviews and surveys of medical providers and patients may enhance understanding of the ambulance signal.

The issue of medically unnecessary ambulance transport is not likely to fade in the near future. There are, however, steps that can be taken in the effort to diminish the problem and its subsequent effects. Though, before any action can be planned, the underlying causes of unnecessary ambulance transport must be identified. This dissertation has highlighted a number of perverse incentives that contribute to the epidemic of emergency ambulance misuse. By removing these incentives, unnecessary ambulance transport would be reduced, thereby decreasing the burden on hospital systems and establishing a more efficient allocation of public funds.

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APPENDIX A: DESCRPITION OF DIAGNOSTIC TESTS

Complete Blood Count (CBC)

The Complete Blood Count (CBC) test evaluates the composition of the patient's blood and reports findings for several blood elements. Components such as red blood cell counts, white blood cell counts, platelet counts, hemoglobin counts, and hematocrit fraction are included. A CBC test can aid in identifying infection, anemia, clotting deficiencies, or other blood disorders.

Blood Urea Nitrogen (BUN)

The Blood Urea Nitrogen (BUN) test evaluates the amount of nitrogen in the bloodstream, in the form of urea. Since urea is expelled via the kidneys, the BUN test is used to assess overall kidney function.

Cardiac Enzymes

Cardiac enzyme testing is performed via blood draw and is used to evaluate the patient's heart, specifically assessing for damage to the heart muscle in the presence of a heart attack. Components of cardiac enzyme testing include creatine kinase, troponin, and myoglobin.

Electrolytes

Electrolyte testing is performed via blood draw and is part of either a Basic Metabolic Panel (BMP) or Comprehensive Metabolic Panel (CMET/CMP) test. This test reports values for sodium, potassium, chloride, calcium, and carbon dioxide present in the bloodstream. Electrolyte testing can aid in many clinical diagnoses and is used to assess the severity of many medical conditions.

Blood Glucose Level (BGL)

The Blood Glucose (BGL) test assesses the amount of sugar, in the form of glucose, present in the bloodstream. Blood is typically drawn via "finger-stick" where a single drop of capillary blood is obtained from the fingertip and evaluated with a glucometer. Not simply confined to diabetic patients, the BGL test can aid in ruling-out/in several clinical etiologies.

Liver Function Test (LFT)

The Liver Function Test (LFT) is used to assess the overall function of a patient's liver. Components such as albumin, alkaline phosphatase, and bilirubin are measured via blood draw. The test can be used to detect hepatic disease or used to evaluate iatrogenic effects from numerous medications.

Arterial Blood Gas (ABG)

The Arterial Blood Gas (ABG) test is commonly used to assess the respiratory and metabolic function of the patient. Unlike other blood draws, which utilize venous blood, the ABG test draws blood directly from a patient's artery. The ABG test measures arterial blood pH, oxygen, carbon dioxide, and bicarbonate levels. The ABG test can be used to detect medical conditions that create systemic acidosis or alkalosis.

Prothrombin Time (PT/INR)

The Prothrombin Time and International Normalized Ratio (PT/INR) test is used to evaluate the clotting ability of the patient's blood. The test is used to assess and screen for bleeding disorders, rule-out clotting disorders before anticoagulant therapy, and as reassessment during long-term anticoagulant therapy.

Blood Cultures

Blood culture tests are used to detect bacteria or fungi in the bloodstream. This test is utilized to assess for infection within the bloodstream.

Cardiac Monitoring

Cardiac monitoring is used to continuously observe a patient's electrocardiogram (EKG). Basic cardiac monitoring visually reports the heart's electrical activity during all phases of cardiac contraction and rest. This basic monitoring displays just one view (lead) of the heart and is used for simple cardiac rhythm interpretation.

12-Lead Electrocardiogram

Similar to basic cardiac monitoring, the 12-Lead EKG allows the medical provider to observe twelve separate views (leads) of the heart's electrical activity. While also used for cardiac rhythm interpretation, the 12-Lead EKG allows for more complex identification of cardiac conditions such as myocardial infarction, ventricular hypertrophy, atrial enlargement, electrical axis deviation, and conduction blocks.

Urine Analysis

Urine analysis tests (urinalysis) are used to evaluate kidney function and aid in medical diagnosis. Utilizing a urine sample, the test detects the presence of electrolytes, proteins, enzymes, blood cells, and other large molecules within the urine.

X-Ray

The X-Ray is a radiological procedure that passes low-dose radiation (x-rays) through the body in order to image dense structures. Bones are the most visible structure produced through this procedure and thus the test is most commonly used to diagnose orthopedic problems such as fractures and osteoporosis.

CAT Scan

Computerized Axial Tomography (CAT) or Computed Tomography (CT) scanning is computer-aided multiple X-Ray technique. CT imaging produces multiple images (or "slices") along the patient's axial, coronal, and sagittal planes. With a much higher level of detail than simple X-Ray, this procedure is used to diagnose and detect many medical conditions such as pulmonary embolism, cerebral hemorrhage, and aortic dissection.

MRI

Magnetic Resonance Imaging (MRI) utilizes strong magnetic fields to produce a detailed image of a patient's internal structures. Similar to the CAT Scan, MRI images are produced along the patient's axial, coronal, and sagittal planes. The MRI is much more useful in the detection of musculoskeletal injuries, such as ligament tears, as the image is able to produce high levels of soft-tissue contrast.

APPENDIX B: MAGNITUDE OF AMBULANCE TRANSPORT POWER

Magnitude of average partial effect of ambulance transport

Service	Non-Ambulance Patients Receiving Service	*Immediate* Group APE (% Change)	*>2 Hours* Group APE (% Change)
CBC	32,523 (32.5%)	0.0561 (17.3%)	0.1429 (44.0%)
BUN	21,750 (21.7%)	0.0762 (35.1%)	0.1046 (48.2%)
ENZYMES	11,045 (11.0%)	0.0278 (25.3%)	0.0546 (49.6%)
ELECTROLYTES	19,185 (19.1%)	0.0575 (30.1%)	0.0887 (46.4%)
BGL	19,782 (19.7%)	0.0700 (35.5%)	0.1028 (52.2%)
LFT	8,652 (8.6%)	0.0306 (35.8%)	0.0490 (57.0%)
ABG	2,702 (2.7%)	0.0691 (255.9%)	0.0189 (70.0%)
PT/INR	6,379 (6.4%)	0.0515 (80.5%)	0.0217 (33.9%)
CULTURES	4,029 (4.0%)	0.0257 (64.3%)	0.0231 (57.8%)
MONITOR	6,196 (6.2%)	0.0764 (123.2%)	0.0483 (77.9%)
EKG	13,708 (13.7%)	0.0541 (39.5%)	0.0983 (71.8%)
URINE	22,363 (22.3%)	0.0818 (36.7%)	0.0978 (43.9%)
XRAY	31,652 (31.6%)	0.0825 (26.1%)	0.1339 (42.4%)
CATSCAN	11,946 (11.9%)	0.1267 (106.5%)	0.1005 (84.5%)
MRI	553 (0.6%)	N/A	N/A