The Description of Hierarchy Bias Concept in Emergency Dispatch Coding and its Implications for Accuracy in Response and Outcome-based Studies

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ABSTRACT

Introduction: The value of dispatch in modern Emergency Medical Services (EMS) systems cannot be understated. Among many other roles, an Emergency Medical Dispatcher (EMD) is responsible for accurate response selection. Response is based on EMD-assigned dispatch codes upon completion of caller-interrogation questions in a dispatch protocol system. When two or more signs, symptoms, or situational conditions are encountered in a calltaker evaluation, but are assigned and reported as a single, dispatch-defined code descriptor during the call-taking process by an EMD, a data hiding "bias," can occur. This phenomenon can be identified in both automated and manual protocol systems. In this study, the phenomenon is termed as "Code Hierarchy Bias".
Objective: The objective of this study was to describe the concept of hierarchy bias in emergency medical dispatch coding and its implications for affecting accuracy in outcome-based studies and dispatch-based and EMS system design and response deployment.
Method: The investigators searched known scientific databases (including PubMed, MEDLINE, and GoogleScholar) of previously published outcome studies for a description and impact of this problem. An examination was conducted to clearly describe it and determine its implications for outcome-based, clinical studies.
Results: The databases search yielded no results for the Code Hierarchy Bias.
Conclusion: The solution to correctly link dispatch decisions to patient outcomes for scientific and operational use rests in the ability to detect all relevant clinical information contained in any singular "code". When these combinations and choices are made, they may result in Code Hierarchy Bias during EMD protocol-based evaluation. The detection of such hidden, specific information can only be accomplished by electronically mining the actual answers (clinical and/or situational specifics) to key questions captured by automated dispatch protocol systems. In addition, in order for dispatch decisions to be clinically accurate, there must be an understanding of the composite clinical make-up of each dispatch code as they relate to outcome findings. This process will enhance the ability to study correctly the critical decisions made by EMDs using prioritization protocols used in optimal deployment of the limited resources of emergency medical systems.

INTRODUCTION

The study of Emergency Medical Services (EMS) effectiveness continues to evolve as scientific-based research matures in the dynamic environments of EMS field response and EMS communication center operations. However, as EMS researchers make progress in identifying new methods for outcome-based studies to determine the true effectiveness of EMS deployment decisions and treatments (beyond traditional cardiac arrest resuscitation, i.e., "yes or no" survival); certain elements of the EMS system remain poorly defined, especially emergency dispatch.

Prior to 1973, only a few Emergency Medical Service agencies had employed even rudimentary communication technologies. The Emergency Medical Services Systems Act of 1973 designated "Communications" as one of its fifteen components. However, the funding emphasis was on hardware, radio frequencies, and vehicle communications rather than dispatcher qualifications, dispatcher training, and protocols.[1] In 1977, development of a protocol-based calltaking and processing system comprised of three essential components (interrogation questions, telephone help, and determinant coding for level of EMS resource deployment) was started. When fully implemented in 1979, this system became known as the Medical Priority Dispatch System® (MPDS).[2] This medical protocol system now has been deployed in over 3,000 dispatch centers in 44 countries. Currently it is in place in 140 of the 200 largest U. S. cities, all provinces but one in Canada, the countries of Australia, New Zealand, Ireland, Kuwait, Qatar, and Malaysia in their entireties, and the majority of the United Kingdom.

In modern EMS systems, the value of dispatch cannot be understated. The trained Emergency Medical Dispatcher (EMD) tooled with medically designed and approved protocols is functionally the first "first responder." The EMD is responsible for not only call-taking activities, but also response selection, resource allocation, and the strategic placement of the remaining emergency medical services (EMS) resources to improve availability for the next call. Response is based on dispatch codes and, therefore, the accuracy and efficiency of these code/response pairings is an obvious necessity. The training and skills of the EMD, combined with the functionality of the MPDS, are emphasized through the official position developed by the National Association of Emergency Medical Services Physicians (NAEMSP®) in 1989[3] and recently updated[4] with a detailed resource document.[5]

The importance of dispatch and need for a systematic approach is stressed by the concept of the "Chain of Survival," which is designed to optimize Return of Spontaneous Circulation (ROSC) for patients experiencing Sudden Cardiac Arrest (SCA). The first two links of the Chain, Early Access and Early Cardiopulmonary Resuscitation (CPR), involve efficient and effective dispatch, and correspond to two essential elements of the MPDS: interrogation questions and telephone help, known commonly today as dispatch life support (DLS).[6]

The development and evolution of the aforementioned third essential component of the MPDS, determinant coding, has become a key factor for the clinical and operational aspects of sophisticated EMS systems.[7] The 457 current determinant codes in the MPDS (version 13.0, October 2015 release, Priority Dispatch Corp, Salt Lake City, Utah, USA) provide a high level of sensitivity and reasonably acceptable specificity for those patients suffering a higher acuity medical emergency, such as SCA, myocardial infarction, breathing problems, and seizures.[8-11] Establishing the correct determinant leads to the proper prioritization of the emergency and the best utilization of the scarce resources for the EMS system, especially during peak utilization times.[12-15] As a result, the use of the MPDS is considered an important characteristic of performance-based EMS system design.[16]

When initiating a study of dispatch outcomes with EMD-assigned dispatch determinant codes (typically referred to as determinant codes), a previously overlooked but essential issue must be considered when establishing the relationship between dispatch protocol codes and outcome findings.[17] This issue involves a previous unreported, fundamental limitation that exists in a dispatch coding system that uses the answers determined by the EMD's interrogation to logically arrive at the ultimate determinant code assigned. In such a system, the various question and answer combinations– representing individual, unique patient conditions– can total in the thousands within a simple four or five question interrogation sequence. Although the number of dispatch codes in the Standard MPDS totals 393, the actual number of determinant code choices available to the EMD during the caller interrogation process is usually limited to less than ten per chief complaint on any given case. Therefore, functional mapping of this vast number of answer combinations to a relatively limited number of code choices requires a set of "weighting" rules that are inherent in the structure of an EMD protocol coding system. These "domain rules", as they are called in the MPDS, account for the "weight" or "risk" value of an answer to a given question, and determine the rank order of which certain signs and symptoms can trump others in the coding process (when more than one finding is encountered). In other words, if the EMD discovers more than one sign or symptom of clinical significance– and a determinant code exists for each of these findings– one determinant code is always recommended above the other, based on the domain rules. In essence, the domain rules determine which answers can or cannot be ignored. The domain rules therefore create, by design, a bias or hierarchal order within the determinant coding process.

The understanding of this bias is essential to deciphering the true association between the data and the apparent outcome results seemingly implied by these codes.[17] The bias occurs when the code-imbedded, multiple symptoms and signs combinations that can be effectively "hidden" within a given code is not taken into account. This bias effect increases the higher each descriptor code resides in the vertical order of a code stack list. Since the bias in dispatch coding has now become identified and better understood, the term "Code Hierarchy Bias" has been coined as the appropriate descriptor for the concept.

OBJECTIVES

This study describes the concept of hierarchical-introduced bias in emergency dispatch coding and its implications for affecting the accuracy of outcome-based dispatch studies.

METHODS

The investigators searched known scientific databases (including PubMed, MEDLINE, and GoogleScholar) of previously published outcome studies for a description and impact of this problem. The search yielded no results for the Code Hierarchy Bias. An examination was conducted to clearly describe it and determine its implications for outcome-based, clinical studies.

MPDS Determinant Code	Determinant Description
CHARLIE-level 1 (C-1)	**Not** alert
CHARLIE-level 2 (C-2)	**Abnormal** behavior
CHARLIE-level 3 (C-3)	**Abnormal** breathing

 The shaded area is the determinant code where the cursor will initially rest.

MPDS: Medical Priority Dispatch System v13.0.

Table 1. Code Hierarchy Bias in the MPDS Protocol 13 (Diabetic Problems)

Description and Implications of Code Hierarchy Bias

In Automated Protocol Systems

The concept of "Code Hierarchy Bias" in the MPDS (version 13.0, August 2015 release) is demonstrated in Table 1. In the provided example, Protocol 13 (Diabetic Problems), clinical-based determinant codes are ranked within the code grouping known as the CHARLIE (C) tier level. The bias here occurs when, during evaluation, the caller or patient reports more than one of the listed signs or symptoms, such as a "not alert" patient who is also presenting with the comorbid of "abnormal breathing". Based on the hierarchy of the codes in each list within an automated system, the initial position of the selection cursor will always start on the first determinant code that logically qualifies– C-1 (Not alert) in this case. As a result, this bias "hides" the second existing symptom of "abnormal breathing" that is also present but not shown in the assigned determinant code of C-1 (Not alert). Therefore, an outcome study pairing the code's basic descriptor only, with a clinical outcome, will "overlook" this secondary, clinical attribute for this patient. This selection bias therefore reduces the number of "abnormal breathing" codes in the rest of any study outcomes.

In research trials and clinical studies that involve a comparison of dispatch determinant codes with observed "outcomes" made by emergency scene paramedics or hospital personnel, a selection of a single determinant code where multiple codes were available, could make it appear that the EMD's assigned code is incorrect, if the second or third symptom descriptor was selected as the principle one for an at-scene or hospital outcome. It is important to remember that dispatch determinant codes, at times, only approximate the sum total of the patient's actual condition (ranging from complete to partial). Obviously, when only one sign or symptom is identified, the coding selection is pure, i.e., no hierarchy bias occurs, and that particular determinant code's value is singular.

MPDS Determinant Code	Determinant Description	Response
CHARLIE-level 1 (C-1)	**Not** alert	Paramedics
CHARLIE-level 2 (C-2)	**Abnormal** behavior	Paramedics
CHARLIE-level 3 (C-3)	**Abnormal** breathing	Paramedics **plus 1st responders**

 The shaded area is the movement of the selection cursor moved to the highest locally-defined response.

MPDS: Medical Priority Dispatch System v13.0.

Table 2. Code selection shift in the MPDS Protocol 13 (Diabetic Problems)

The ability of individual EMDs to "shift" from the automated system's initially recommended (selected) determinant code to another listed, available, determinant code creates another variable, but does not eliminate the bias. Returning to the Diabetic Problems Protocol's example, the initial determinant code selection highlighted can be "shifted" to C-3 (Abnormal breathing) by the EMD if deemed appropriate since it also is a "true" (but not singular) finding for this patient (Table 2). This shift is typically done only in systems that have locally assigned a higher level of "response" to another available (logically qualified code, as shown in the table.

Within each protocol's determinant code-list hierarchy, significant attempts have been made during the development of the MPDS logic systems and their testing, to list the various "main" conditions (signs and symptoms determined) in order of clinical importance. This is not always possible since the clinical significance of each code (compared to others, and with regard to individual patients) may not be readily apparent. In many cases, codes within a given level were considered to have the same, or nearly the same, clinical significance resulting in that level's initial grouping. In some groups, the individual codes listed are not directly related to one another (heterogeneous). In es-

MPDS Determinant Code	Determinant Description
DELTA-level 1 (D-1)	**MAJOR INCIDENT** (**a** through **e**)
DELTA-level 2 (D-2)	**HIGH MECHANISM** (**k** through **s**)
DELTA-level 3 (D-3)	**HAZMAT**
DELTA-level 4 (D-4)	**Pinned** (trapped) victim
DELTA-level 5 (D-5)	**Not** alert

MPDS: Medical Priority Dispatch System v13.0.

Table 3. The clinical significance in the MPDS Protocol 29 (Traffic/Transportation Incidents)

sence, they are more "horizontal" in alignment than "vertical" in ranking their comparative values.

For several chief complaints, clinical significance is not the primary consideration in determinant code-list groups. In MPDS Protocol 29 (Traffic/Transportation Incidents) (Table 3), for example, the DELTA-code group is an amalgamation of disparate determinant code conditions (Not alert, Pinned (Trapped), HAZMAT, HIGH MECHANISM, and MAJOR INCIDENT). The hierarchy of this list, in a question choice array, is not based on any particular rank order of clinical significance; rather, they are choices that relate to the various specialized responses often needed, given the circumstances unique to the event. Clearly, one determinant code's descriptor may or may not be more important than another, but in the coding process, only one can be selected and the result is a case coded with only a singular value visible based on the code.

Manual Protocol Card Systems

In a manual protocol card system, the same bias occurs (Table 4). However, it is not necessarily vertical in hierarchy because it is calltaker-introduced and based on specifically which one of the multiple signs and/or symptoms each EMD can select, varying from case-to-case and dispatcher-to-dispatcher. The manual selection process also hides other present, possibly related signs and symptoms findings within the coding umbrella of each reported situation when more than one sign, symptom, or condition is determined to be present. However, any code-based data gathered in a study only records, assesses, and reports on the single determinant code selected by the EMD, also potentially raising questions as to the validity of the stated results. In the aforementioned example, the EMD manually

MPDS Determinant Code	Determinant Description
CHARLIE-level 1 (C-1)	**Not** alert
CHARLIE-level 2 (C-2)	**Abnormal** behavior
CHARLIE-level 3 (C-3)	**Abnormal** breathing

 The shaded area is the movement of the selection cursor moved to the highest locally-defined response.

MPDS: Medical Priority Dispatch System v13.0.

Table 4. The manual protocol card system in the MPDS Protocol 13 (Diabetic Problems)

selects C-3 (Abnormal breathing), but, again, the "not alert" sign, if also present, is also hidden by that selection.

It is important to emphasize that the determinant code selected by the EMD is not entirely random when more than one condition is present. EMDs are instructed to select the first applicable code descriptor in the list, unless a higher level of response is assigned to a determinant code located lower in the code group. Although variance in code selection is likely higher in manual systems, it is not entirely unpredictable.

DISCUSSION

The ability to detect accurate clinical information in the dispatch environment is critical for those responding to the patient. As a result, combinations hidden by a specific determinant code choice, resulting in "Code Hierarchy Bias," can be problematic as it may also bias the initial scene assessment of that patient. The solution lies in the electronic mining of the actual answers to individual questions reported by the calling party to the EMD and captured by automated dispatch protocol systems, or the creation of expanded, previously "concealed" determinant codes (i.e., not for response purposes) that reflect the true individuality of a specific patient's condition. While not a simple process, we assert that these are virtually the only ways to accurately relate clinical outcome findings to assigned determinant codes and, subsequently determine, which patients ultimately represent high vs. low acuities.

An important current example of this is MPDS v13.0 Protocol 6 (Breathing Problems) (see Fig. 1). The outcome bias created by multiple conditions included in a single code definition is therefore compounded within the bias introduced by code hierarchy. Since other possibly related signs, symptoms, and situational conditions (represented as separate codes) follow after D-2, they can also be present, but are hidden, outcome-wise, in the EMD's choice of D-2. The signs and symptoms represented by D-1 (Not alert) and/or D-4 (Clammy) may also be present in a D-2 coded patient. In actuality, there are 14 different combinations of signs and symptoms (i.e., different clinical presentations) in the Protocol 6 DELTA tier alone. One includes all possible signs and symptoms while, in the lower hierarchy of the stacked array, D-4 (Clammy), when selected, is only "clammy" and

MPDS: Medical Priority Dispatch System v12.1

DSBB: Difficulty Speaking Between Breaths

Figure 1: Medical Priority Dispatch System Protocol 6 (Breathing Problems) DELTA-level (Not alert) situations– shaded boxes.

excludes all other signs and symptoms. In an automated system, or manual top-to-bottom selection, this is the only clinically pure code in this group.

A secondary bias is encountered when two or more signs, symptoms, or situational conditions are included in a single, dispatch-defined code descriptor (Table 5). This is demonstrated by the following code array found in the MPDS v13.0 Protocol 6 (Breathing Problems).

MPDS Determinant Code	Determinant Description
ECHO-level 1 (E-1)	**INEFFECTIVE BREATHING**
DELTA-level 1 (D-1)	**Not** alert
DELTA-level 2 (D-2)	**DIFFICULTY SPEAKING BETWEEN BREATHS**
DELTA-level 3 (D-3)	**CHANGING COLOR**
DELTA-level 4 (D-4)	**Clammy**
CHARLIE-level 1 (C-1)	**Abnormal** breathing

MPDS: Medical Priority Dispatch System v13.0.

Table 5. Signs, symptoms, or situational conditions buried in the code – the MPDS Protocol 6 *(Breathing Problems)*

The DELTA-level 2 (D-2) –*"Severe Respiratory Distress"* determinant code is a defined condition group that includes the following possibly related conditions: *"Changing color"* and *"Difficulty speaking between breaths"* (unable to complete a full sentence without breathing; can only speak a few works at a time). This code can be triggered by either *"Changing color"* or *"Difficulty speaking between breaths"* or by both factors. If only the end-point determinant codes and their text descriptors are used to identify patient relationships with clinical outcomes, this again could mask the actual and full nature of the problem first encountered by the EMD. Therefore, the D-2 *(Severe Respiratory Distress code)* code alone can indicate clinically eight different situations (as shown in Fig. 1).

A methodology based on this study has now been implemented in the MPDS to overcome such bias through the identification of each of the multiple conditions that may be included in a single determinant code/descriptor, and by separating them into all singular research determinant code condition options. Although this methodology inherently creates more individual pure codes, it eliminates the secondary bias created by using definitions that include multiple signs and/or symptoms. However, this can only be done in automated logic-based dispatch systems.

There is a potential that low acuity codes may essentially escape certain aspects of the code biasing effect because they are selected as the result of the previous elimination of virtually all other priority signs and symptoms.[18] However, if more than one code in a low acuity group exists, a form of bias is present by definition.

Overarching the discussion of "Code Hierarchy Bias" is the previously reported need for call-taker compliance in ensuring coding accuracy.[19] This requirement must be the first and foremost attribute for the data used in any dispatch-based, protocol-use study.[17] In International Academies of Emergency Dispatch (IAED)-accredited dispatch centers, active quality improvement programs require continual monitoring of the dispatcher's performance, data analysis, and high compliance to a predetermined accuracy percentage in seven different protocol evaluation areas, and more recently in Standard 9a, where individual EMD's deviations from standard protocol practice have been divided into the four, defined categories of CRITICAL, MAJOR, MODERATE, and MINOR.[20]

For research sites involved in ongoing studies, clearly identifying the exact MPDS, or other, protocol version is also a dispatch-study essential[21,22], since code hierarchy bias details may vary per protocol. This is of critical importance as more multisite studies are undertaken involving dispatch outcome accuracy and EMS system design and deployment issues.

CONCLUSION

Response in modern EMS system designs is based on dispatch coding, and therefore the accuracy and efficiency of those codes to determine the appropriate response, is a necessity. The definition and description of Code Hierarchy Bias in this concept paper demonstrate that, for dispatch decisions to be clinically accurate there must be an adequate understanding of the clinical content and true significance of each dispatch determinant code as it relates to evidence-based research and any subsequent outcome-finding claims. Any dispatch data and outcome so relied upon must be evaluated regarding the possible effects of Code Hierarchy Bias before any recommendations or conclusions are regarded as correct. The detection of specific patient information can only be accomplished by electronically mining the actual answers (i.e., clinical specifics) to key questions captured by automated dispatch protocol systems. In the end, this will ultimately enhance our ability to scientifically study the critical interrogation-based decisions made by EMDs employing structured prioritization protocols used to deploy our limited EMS systems' resources efficiently and effectively. The result can be a better understanding that will lead to a strengthening of the earliest links of the Chain of Survival and, ultimately, better care for our patients and EMS system response reliability for our communities.

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Declaration of interest: Jeff Clawson MD is the inventor of the Medical Priority Dispatch Protocol System (MPDS) studied herein.

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