Emergency Medicine Under Fire:

Modernization in the Pre-Hospital Sector

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Abstract:

Transformation of existing emergency medicine dispatch and triage, combined with streamlined EMS documentation, billing, and compliance will create an outsized impact in the field of emergency care in the next decade. Pre-hospital care will become the largest bottleneck for emergency medicine, but burgeoning technology represents an opportunity to shift from a hospital-centric, reactive system to a proactive, decision-driven, pre-hospital network. The largest opportunity in emergency medicine is fundamentally not improving care delivery but reorganizing patient triage and routing before they ever reach the hospital.

Keywords:

Emergency medicine, pre-hospital care, triage, dispatch, documentation, AI, proactive

Market Overview

Emergency medicine is one of the largest sectors of the US healthcare system, with emergency departments accounting for over 155 millions visits annually (CDC). In the United States alone,

the emergency medicine market is estimated at $216 billion, with estimates of $340 billion by 2033 due to America's rapidly aging population and increasing diseases of affluence (Grand View Research). Over half of all hospital admissions now come by way of the emergency department, and over 20% of Americans have their first contact with healthcare through a 911 call (International Journal for Health Services, 2017). Despite functioning as the "safety net of the safety net," however, emergency medicine is by far the most strained segment of US healthcare, with an increasing number of unmatched positions for residencies, a lack of emergency medical presence in rural areas, and overcrowding ("logjams") within ED, resulting in patients unable to move to inpatient units or post-care facilities (Clinical and Experimental Emergency Medicine, 2018). Perhaps the biggest source of difficulty is technological and infrastructural insufficiencies, which combined with a large rate of burnout and stress, result in gross waste. Thus, despite emergency medicine shifting to the central role in Americans' interaction with the healthcare system, emergency medicine has never been more overlooked — monetarily, socially, and legislatively. The public sector is unable to and unwilling to address deficiencies, creating an asymmetric opportunity for private companies to build in a historically neglected but system-critical layer within the incumbent-dominated field of healthcare.

Nowhere within emergency medicine, though, is inefficiency more evident than in pre-hospital care (rapid treatment and ambulance transport), the field I work in. With 5.2 medical 911 calls a second, pre-hospital care is many patients' first encounter with the US healthcare system yet is consistently the last medical sector to modernize (NENA). Pre-hospital care's stubborn resistance to change is multifaceted. EMS is composed of thousands of fragmented independent authorities (with a roughly even split between fire-based/public EMS agencies and private EMS companies,

EMS1), each with their own practices, protocols, and siloed data. EMS is often seen as a business afterthought, with most companies in the space focusing on the more lucrative hospital software, triaging, and support. Finally, many EMTs are distrustful of innovations for fear of worsening patient outcomes. EMS, therefore, is a sector that has not substantially changed since 1975 and is uniquely positioned for innovation. As a market, EMS is less saturated and represents an appealing spearhead into the more crowded and larger emergency hospital system. With that in mind, there are four main inefficiencies in EMS, each representing billions of upside.

Misaligned Incentives: Transport Instead of Triage

The issues in pre-hospital care start at the 911 call itself. In nearly all cases, a full emergency response is provided for any call, yet sixty percent of calls are low-acuity cases not necessitating an emergency response (PLoS One). This represents a drastic failure of pre-hospital systems to appropriately triage calls. Often, EMS functions primarily as a logistics system instead of a clinical decision-making operation, arranging responses to the patient instead of considering which response is best. For example, while some agencies are starting to use designated basic life support (BLS) and advanced life support (ALS) units, the majority of agencies still send one paramedic (ALS) and one EMT (BLS), or even two paramedics per call. Speaking personally in San Francisco and Houston, most EMS agencies are unsure/hesitant about patient conditions and err on overresponding.

The issues compound with patient transport, especially in non-emergency situations. Though the majority of 911 medical calls are non-emergency, a majority of non-emergency calls nonetheless result in transports to emergency departments. The decision to transport instead of releasing care

is generally a combination of patient insistence and a fear of EMS providers of being sued for negligence if they possibly missed a condition. In their eyes, it is always better to pass authority and blame to ED doctors and nurses. Therefore, EMS providers generally are instructed to always transport whenever possible. However, constant over-transports create the aforementioned logjams in EDs and prevent critically injured patients from receiving the support they need. Innovation must improve triaging and transport decisions in the pre-hospital setting.

Chronic Underfunding and Negative Unit Economics

The costs per transport for an EMS agency have also risen dramatically in recent years, with the mean cost per transport reaching $2,673 (of note: governmental agencies cost on average $3,127; private agencies cost $1,778), yet the reimbursement across all payers is only $1,147, meaning that a typical transport produces a revenue shortfall of $1,526 (NAEMT). Since 73% (22.9 million) of the total 31.2 million ground ambulance responses resulted in transports, the revenue loss of operating soon balloon (by some estimates, up to $35 billion lost yearly). Furthermore, many agencies (like San Mateo, for instance) do not charge patients for non-transport calls at all. Therefore, ~30% of non-transport calls result in no compensation whatsoever, meaning that a non-transport call costs an agency ~$496 to $959, resulting in $4.2 to $8.1 billion lost in completely uncompensated calls. It is no surprise, then, that many EMS agencies with “treat, no transport” policies have an incentive to transport patients as often as possible to at least partially recoup costs of response — of course, only adding to backlogs at the ED.

While some agencies (San Jose, Alameda, Napa) have recently begun introducing “first responder fees” in an effort to recoup costs, these charges are only for advanced medical care

provided in the field (minor treatment is excluded), and fees cannot be billed to patients without insurance, like the unhoused (who use emergency services 19 times more than insured, housed individuals; LAFD). Still, even these "first responder fees" miss the mark because just the act of a response is what creates revenue shortfalls for agencies, regardless of if treatment is provided. Since most EMS agencies (whether public or private) are supported by municipal loans, these loans will only become more costly as emergency medical services become more taxed. Fundamentally, the system is unprofitable. Innovation has to either increase reimbursement or reduce cost, and as patients have resisted decades-long struggles to increase EMS billed costs, innovation must cut down on expenses instead. The most obvious expense is manpower: 69% of EMS budgets go to staffing (Public Consulting Group). Agencies improve their profitability by finding ways to hire less EMTs or be more judicious with the staff on hand.

Documentation and Data Fragmentation

However, it is not just the operational bottleneck that constrains EMS agencies. Fundamentally, documentation and billing drastically prevent the effectiveness of all emergency medical providers. For all healthcare workers, roughly 40% of time is spent on documentation, with only 30% of time spent on direct patient contact (IJIER). In the field of emergency medicine, estimates range as high as 65% of time spent on electronic health records (Perspectives in Health Information Management). Speaking from personal experience, up to half of an EMS twelve hour shift is spent either coding patient encounters; documenting in meticulous detail initial patient disposition, interventions administered, and patient condition upon transfer to a hospital; or preparing for billing and invoices. While this issue is nothing new to healthcare, previous efforts to address it have been insufficient (Mayo Clinic Proceedings). In the realm of emergency

departments, total “busywork” physician time has only decreased to two hours (from three) despite nationwide adoption of medical scribes. Furthermore, on mobile EMS units, scribes are rarely, if ever, used (to save money). Even electronic health records, long theorized to be the panacea to documentation-related costs, have not had a meaningful effect. As one study puts it, “Research has shown that EHRs have not reduced physician data entry time” (Perspectives in Health Information Management). Even in the EHR-era, time and monetary costs related to documentation and billing have only increased, uniquely in America, where healthcare providers spend four times more time filling out paperwork than in Canada.

The hassle, inefficiency, and fatigue associated with documentation and billing then causes many EMS providers to neglect documentation of all treatments provided, resulting in loss revenue (from failure to bill for administered treatments; particularly for small to mid-sized EDs) upwards of hundreds of thousands of dollars per year (SCP Health). Perhaps the biggest benefit to more efficient documentation and billing is to the patient themselves. As JAMA puts it, “Reclaimed 10-minute clinical time difference on shift can allow providers to do things only a provider can do.” Freeing up the time of EMS providers allows them to do what they do best: save patient lives.

Workforce Burnout & Capacity Collapse

The average emergency call takes 30 minutes without a transport, and from 1 (urban) to 3 (rural) hours with a patient transport. Since the vast majority of calls are not emergencies, and documentation swallows up time in genuine crises, EMS agencies waste hours per day, resulting in chronic overwork for EMTs and paramedics. For instance, 59% of EMS agencies report an

inability to meet 911 call demand. (EMS1). 76% of EMTs consider burnout a critical issue. A majority of EMTs never get the recommended amounts of exercise and sleep. And 23-36% of EMS clinicians leave their job annually; up from 16% in 2018 (University of Washington). The "EMS Exodus" is beginning, where more providers are retiring or leaving than being hired, increasing the strain on the existing bare-bones staff.

Thus, the issues that plague EMS become a self-fulfilling "death spiral:" EMS agencies are understaffed and unable to respond to existing calls; still, they nonetheless send a full response to nearly every call — including non-emergencies — due to inefficiencies in triaging. The majority of these responses end up in transports, creating revenue shortfalls, and the "treat, no transport" calls create even worse budgetary issues for the agency. Afterwards, the EMS providers are consumed with documentation, increasing the amount of time until they can be call-ready again. Documentation and overresponse force EMS providers to work long hours — often 24 to 48 hour shifts — to cope with demand. Long hours and inadequate pay (from the budgetary constraints) create high rates of burnout and sleepier, sloppier EMTs more prone to injury. Churn and turnover increase, further destabilizing the EMS workforce. The cycle repeats, with inefficiency and backup spreading from pre-hospital services to hospital emergency departments to the broader healthcare system.

Emerging Technological Shift

The $200 billion dollar emergency medicine system is overdue for a transformation, and the first system to change is likely the $55 billion pre-hospital healthcare market (Fortune Business Insights). EMS agency modernization will almost certainly be the jumping-off point that

launches drastic overhauls of the entire ED department. Of the four structural issues mentioned earlier, three high-upside solutions categories are going to drive transformation in the next decade.

AI-Powered Documentation & Automation

The most immediate and commercially viable solution lies in automating EMS documentation and billing, which consume up to half of provider time. Artificial intelligence has reached the level of maturity where general-purpose AI scribes are feasible, and indeed there are many burgeoning healthcare-specific scribes jockeying for usage in hospitals. Still, pre-hospital adoption has been slow. Part of the reason is regulatory hurdles; in California and other two-party consent states, the patient must consent to being recorded by the scribing software, even if no data is sent to the scribe's centers. Often, EMS patients are also intensely distrustful of the entire healthcare system and do not consent to being recorded in any way. A secondary reason is that current AI scribes were built with calmer, structured hospital visits in mind — where primary care providers have the time to ask all relevant questions. Many EMS calls are just too frantic for current scribes, often with more unanswered questions than not — if a patient can speak at all. Lastly, EMS provider adoption is difficult because EMS providers themselves are hesitant to spend valuable call time obtaining explicit patient consent.

Perhaps the greatest difficulty is that a majority of EMS documentation does not rely on verbal communication. It includes notes about patient appearance, condition, disposition, interactions with family, wounds, etc. Progress is being made toward multimodal scribes (integrating visual, auditory, and even tactile information), which might excel in replacing provider-directed EMS

documentation. In the near future, though, the most feasible software (regulatorily and technologically) would likely turn EMS provider voice summaries into structured reports (eliminating manual data entry), which would then be automatically sent to both the hospital and the billing office while the ambulance is en route to the hospital. Such en-route voice-summary software will also achieve broader adoption by current providers than real-time recording/scribe software because it puts the EMT's experience — what they saw, felt, heard, and think — at the center of the report. The data integration into the broader hospital and insurance environments is where true payoffs occur, however.

Currently, ePCR systems are not uniformly integrated with hospitals. Many counties rely on fax, static uploads, and manual re-entry when EMS hands off a patient to the hospital. Recently, some EMS ePCR systems have begun interfacing directly with hospital patient management systems (Epic, Cerner), but often, data is sent after the call and that data is not meaningfully integrated into a patient's health record. Synchronous and consistent integration, by contrast, allows hospitals to uniquely prep for incoming patients, cuts down greatly on hand-off time, and represents a step toward true longitudinal patient records.

The leap from scribe to filing with insurance is similarly necessary to allow EMS teams to better optimize for reimbursement. Typically, ePCR reports feed into billing platforms, where the EMS agency's back office must handle coding, claim submission, and payer interaction. Integrating billing and coding into automated documentation removes the sluggish paper trail, coupling billing to care delivery. Allowing the EMTs to send coded documentation directly into billing

systems also decreases errors/omissions in documentation of care administered, increasing agency revenue.

The immediate ROI from reduced documentation effort and enhanced billing capture means AI-powered scribing is the lowest-friction entry point for EMS modernization, forming the cornerstone of future EMS streamlining.

Real-Time Interoperability & Hospital Integration

Automatic documentation can only solve the most basic EMS issues. Greater and longer-term benefits come from solving the deeper fragmentation between EMS providers and hospital systems. Fundamentally, EMTs have next to no clue as to hospital conditions during transport. Speaking from experience, sometimes, they call a hospital en-route asking about capacity, but often they just take a patient to the first in-network hospital or a clinic the patient has been to before. This means that EMS often arrive at an overcrowded clinic and wait up to an hour or more before transferring their patient.

However, novel routing platforms and API layers between EMS and hospitals offer the ability for EMS agencies to have real-time hospital capacity visibility, tangibly improving decision-making. In the longer-term, EMS routing could move toward automatic optimization based on hospital conditions, patient insurance, severity of injury, and other factors, spreading the load among EDs and adding tangible hours back to EMS shifts. Interoperability is the infrastructure layer necessary to tap into system-wide efficiency gains.

Predictive Triage & Decision Support

The most transformative, but longer-term, opportunity lies in shifting EMS from transport-based logistics to clinical decision-making systems. Deep interconnectedness between EMS and hospitals is a start, but the true benefit of unifying EMS data and strengthening the connections to local clinics is to create a more effective dispatch system entirely.

Fundamentally, dispatch is untenable. Dispatch systems make high-stakes decisions on limited data and incredible time constraints, all through a very human foundation. With improvements in continuous data infrastructure, such as through documentation and interoperability improvements, dispatch will likely evolve into a proactive resource allocation system.

Instead of reactive call routing — focusing on if the patient can be reached — dispatch will likely now determine what agency should reach the patient, where the patient should go, and *if* the patient should even be transported. Automated documentation and hospital interoperability are the stepping stones to a system that goes beyond responding to emergency medical calls, simultaneously evaluating available resources and staff, triaging the patient, and planning appropriate responses.

Finally, the interconnected dispatch system will likely do what existing dispatch fails to do: *learn*. The outcomes of millions of calls a day can be used to better identify geographic demand patterns, at-risk demographics, and treatment trends, creating powerful feedback loops at a patient, system, and population level. For the patient, a unified intermediate

documentation layer allows EMS to pull up previous encounters while en route to the scene, resulting in faster and more effective treatments. At a systems level, hospitals can prepare while en route, and EMS can choose less crowded hospitals. Zooming out, EMS agencies can consistently improve off of and learn from other agencies nationwide, while nonetheless tailoring their services to their specific market.

Of course, this paradigm shift is not accomplished overnight. Unifying data and connecting hospitals is still a relatively novel idea, hampered by legislative restraints. Significant investment in data infrastructure and integration must be made. But predictive triage offers the highest-upside opportunity, and companies have begun building toward it.

Shift Toward Value-Based Care

The transformation from automated documentation to a novel dispatch system will promise better patient outcomes, but at its core, this network is a tool to improve the unit economics of EMS by cutting down on inefficiency and allowing providers to return to call readiness quicker. The average EMS provider will likely work shorter shifts, improving EMS agencies' profitability drastically. Indeed, EMS becomes the decision-maker instead of a transporter, corresponding with the nascent transition from fee-for-service to value-based care. Because patients will likely be transported less, and only charged for care actually provided, their bills decrease, too, even as EMS agencies nonetheless improve profit through increased provider availability. EDs gradually become less jammed, resulting in improvements to patient care (measured by time to treatment), as well.

This technological shift offers the chance to redefine EMS from people-moving to a distributed clinical intelligence network. In the process, a new category of business opportunities are created centered on workflow integration, decision support, and real-time system coordination.

Competitive Landscape & Emerging Players

EPCR & AI Documentation

The realm of documentation and ePCR systems is difficult to break into because success is dependent on individual agency adoption, which often takes months to years. Still, the market has become increasingly cluttered, with one rapidly growing enterprise — FirstDue — and three major EMS incumbents: Zoll emsCharts, ESO, and ImageTrend. However, all four primarily function as system-of-record tools, not intelligence ones. They digitize documentation, reduce manual entry, often offer compliance and billing software, and sometimes offer limited interoperability, but they only serve to support existing archaic workflows in emergency medicine.

There are fundamentally three layers to documentation. There is the first layer of data capture, turning EMS responders' voice notes into structured reports. The second layer is workflow integration, moving this data into hospitals and billing departments. The third layer is intelligence-driven, garnering insights from documentation and tangibly improving patient interactions. None of these four companies has expanded across all three layers, with most competing over layers one and two. For instance, ImageTrend's AI Assist represents a step in the right direction, turning voice input into structured user data. Yet ImageTrend lacks deep hospital

integration and offers almost no billing support. Zoll fares better in terms of billing but performs worse in terms of data entry.

Of note, FirstDue is the most interesting current option for its Advanced Data Insights. FirstDue offers the beginnings of intelligence-driven documentation analysis, with basic geocentric and demographic insights, as well as case metrics and some transport patterns. However, insights do not equal improvement. FirstDue does not use these insights to guide decision-making, and perhaps more importantly, insights are siloed by agency, reducing benefits obtained from analyzing data at scale.

None of the four dominant companies have fully shifted to a more abstract scale, where they move from inputs to insights. Therefore, existing ePCR systems do not meaningfully reduce cognitive load, support real-time decision making, or create inter-system intelligence.

Hospital Interconnectedness

The market for interoperability and hospital communication is quite limited, with only one real company facilitating interactions between EMS and hospitals: Pulsara. To specify, most — if not all — of the four ePCR companies mentioned earlier have the capacity to send some form of patient data to hospitals. However, true communication conveying hospital crowding, wait times, available physicians, etc does not exist.

Pulsara is most often used in crises (particularly cardiac arrest, stroke, and pulmonary issues) to allow physicians to advise EMTs during transport. Pulsara excels at the ability to share patient

information (including images and tests from the field, like ECGs) with the hospital, allowing hospitals that use Pulsara to prepare before patient arrival for time-sensitive treatments, like clot-busters in stroke treatment. Pulsara has recently expanded to general transfer protocol, aiming to replace the radio report and reduce handoff times.

Fundamentally, though, Pulsara connects physicians and individual hospitals to patients. EMS providers still have limited to no information as to hospital conditions/wait times. How Pulsara is set up prevents the infrastructure from ever being developed that could automatically optimize transport routing to more evenly spread load among EDs and reduce logjams. Current EMS-hospital platforms support communication and coordination yet neglect creating the infrastructure to improve decision-making.

Networked Decision-Making, Dispatch & Triage

There exists no current dispatching software that approaches the decision-making capabilities needed to upend emergency medicine. Currently, the market is dominated by Motorola, CentralSquare, and Hexagon Intergraph, all of which offer computer-assisted dispatch (CAD) that receive 911 calls, assign units, and handle routing. These solutions offer only modest data insights, with basic geographic and demographic trends. Recently, additional data layers have been created that feed additional information into CAD systems (RapidSOS is the most prominent example; pulls data from smartphones, connected devices, the internet, and first responders to improve dispatch). RapidSOS is promising in that it increases data availability, as well as integrates AI for incident records, transcriptions, and even the beginnings of protocol-recommended responses.

Still, dispatch remains stubbornly human-driven. The responses that RapidSOS suggests come directly from the 911 operator manual and do not represent any sort of pattern recognition or learning from thousands of prior dispatches in the area. Furthermore, the intense competition between rival CAD software leads to data silos that actively hinder large-scale learning from calls. Perhaps most detrimental to emergency medicine is that all existing solutions are designed for police dispatch first.

True decision intelligence software is the key to remedying the intense inefficiency of emergency medicine. All-in-one EMS platforms, such as the recently developed Traumasoft, are encouraging. But even these "bundled" platforms focus on aggregation rather than integration and therefore never approach intelligence.

Thus, despite diverse vendors from dispatch to documentation, the EMS software ecosystem remains highly fragmented. Incumbents control system-of-record workflows, while newer companies focus more on coordination, communication, and additional data integration. No company yet, though, has unified the disparate layers into an immediate decision-oriented platform capable of shifting EMS into a proactive clinical intelligence network. The company that builds across all layers over the next ten years will solve the emergency medicine bottleneck, redefining emergency care to be predictive and pre-hospital focused, taking the burden — and emphasis — off of hospitals for treatment.