Collaboration of Cultures: Aviation and Healthcare in Helicopter Air Ambulance Service

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Abstract: Healthcare and aviation leaders combine their unique expertise to provide expedited critical care medical services through complex aviation operations; however, various organizational structures, standards and procedures, and inter-industry professional cultures can drastically affect the effectiveness and safety of aviation operations. The vast majority of helicopter air ambulance (HAA) programs comprise an inter-industry contractual agreement between healthcare providers and aviation companies. Beyond the agreements between aviation service providers and their customers, healthcare and aviation professional cultures collide to form HAA programs as unique as the area they serve and the hospitals they support. The aviation professionals and medical clinicians are then left to function together as a team in a high stress and unpredictable environment. This study seeks to identify threatening deficiencies to aviation safety that result from the differences in professional cultures and ineffective collaboration within HAA programs and find potential solutions from similar organizational or industry models**.**

Keywords: helicopter; air ambulance; professional culture; aviation safety; healthcare; aviation

1. Introduction

The helicopter air ambulance (HAA) industry unites two highly skilled professions, aviation and healthcare, in order to provide the general public with on-demand critical care medical services. Both professions emulate values and practice procedures based on the learned lessons from those that came before them within their respective industries, evolving the disciplines and further developing their independent cultures. The professional health and safety literature and practice is replete with guidance on building effective safety management systems and individual elements (such as human performance, hazard recognition and mitigation, training, and reporting). The underlying premise of safety management systems and their elements is: institute these approaches and comply with these regulations, and you will create a safe workplace and minimize opportunities for accidents. Such approaches, codes and standards,

training and more are indeed important and essential tools. There are numerous organizations that operate in this environment.

As of September 2018, the HAA industry is comprised of 263 air medical service providers with 1,111 total rotary-wing aircraft located at 960 bases throughout the country [1]. Of the 263 air medical programs, there are essentially three different business models that contain various employment, professional, and organizational structures, including (1) hospital-based, privately-owned or contracted, (2) community-based or independent, and (3) government-operated programs. A fourth business model, called a hybrid program, is principally a community-based model in partnership with a specific hospital. The aviation services provided within the HAA industry all operate under Code of Federal Regulations (CFR) Title 14 Part 135 rules and regulations. In short, these Federal Aviation Administration (FAA) regulations provide a higher level of safety as opposed to basic not for hire flight operations. Because of these different business models, safety culture development and interface between aircraft operators and medical organizations can be challenging.

With hospital-based programs, the hospital owns the service; owning the aircraft, employing the medical staff, providing medical direction, and processing all-inclusive billing to the patients. In contrast, the community-based program aviation operator owns the service by employing or contracting the medical staff and direction, as well as handling all aspects of air medical transportation billing. Community-based programs are independent in nature and not associated with any one particular hospital or healthcare system, and therefore rely solely on patient transport volume in order to profit. The aviation operator in hospital-based models profits from the fixed price that is agreed upon in the contractual agreement, regardless of patient transport volume. Hybrid HAA models effectively allow hospitals the ability to associate an air medical service with their healthcare network or system and mutually agree with the aviation operator to transport patients to their facilities; however, the hospital ultimately does not have the final authority of the air medical base locations or whether particular bases remain open, based on the volume of patient transports. Additionally, there are few hospital systems that are privately owned; however, these are in the minority and will be examined in similarity to hospital-based programs for the purposes of this study. These definitions are broad and not intended to define every possible HAA business model or contractual relationship between healthcare and aviation providers.

These business models and organizational structures are relevant because of the leadership hierarchies by industry and the respective leaders' ability to influence and establish a culture within an organization that could affect an external or supporting professional (i.e. aviation) culture; therefore, the background and experiences (i.e. professional culture) of those leaders drastically affect the potential of change specifically in overall aviation safety culture. This broadly sets the stage and defines the environment in which the HAA industry inter-professional relationships and cultural complexities exist.

Helmreich and Merritt [2](p. 1) comprehensibly described that, "culture fashions a complex framework of national, organizational, and professional attitudes and values within which groups and individuals function" and "is an abstract construct that must be inferred from behavior, self-report, and artifact". This study focuses primarily on the professional cultures of aviation and healthcare within the United States, and accepts that all organizations promote their own vision of a safety culture and teamwork within their operations; acknowledging that organizational cultures contribute to the overall perceived culture within a group of individuals. The studies reviewed have examined quantitatively and qualitatively both of these professional cultures separately; however, to what effect and degree do the combined cultures have on the other during their joint participation within an aircraft crew environment? Does the overall aviation safety culture suffer within the HAA industry as a result of inadequately unifying and collectively training two very unique professional cultures? To accurately explore these questions, this paper begins with studied examples of similar events, variables, and environments to understand all aspects and factors affecting each element of this problem.

2. HealthCare Culture

The effect of professional culture of each industry is best examined individually first, which will provide context to the behaviors and mindset of the respective professions. While organizational culture can determine the overall effectiveness, productivity, and safety of an organization established by the leadership, professional culture is the foundation from which organizational culture originates. Healthcare professionals and the leaders that guide their efforts are influenced by medically-driven factors as they pertain towards patient treatment, and do not necessarily conform with or focus on areas that other professional cultures, such as the aviation industry, deem critical to success. Culture is viewed as a set of perceptions shared by members of a team or organization, and is acquired through social learning and processes that expose individuals to a diversity of culture-bearing elements [3]. Through years of indoctrination and experience, individuals are exposed to and mentored with a specific way of viewing how things should be done. Generally speaking, throughout a particular profession or industry there are few external influences that can effect change in a culture; federal and state regulations or law, public opinion, and market pressures are just a few. The industry and organizational leadership establish areas of focus, and therefore, shape what individuals within their respective organizations perceive as culture; and this only begins to explain the complexity of professional culture, as defined inside an organization or industry. The fundamental understanding from where culture derives is crucial to visualizing the challenge and learning about each specific culture, aviation and healthcare that reside within the HAA industry.

The high-stress environment in which emergency medical services (EMS) and HAA reside make the nature of the service extremely unique. Each discipline, aviation and healthcare services, bring with them a multitude of highly-technical methods and procedures that concentrate on various aspects, from accomplishing a specific task to achieving a collective goal. How each function, task, or result is measured as a success or failure can widely differ between the professions. For example, one method healthcare measures success and failure is by a process called a varying reliability scale; for which processes, procedures, and services are able to perform their intended function in the required time under existing conditions, which is quantitatively identified, and any process having greater than 20% failure rate is labeled as "chaotic" [4]. This defined failure rate would equate to an overwhelmingly unacceptable level of incidents by aviation standards, regardless of the task. By comparison, the two industries manage starkly different tasks, challenges, and circumstances within even more dissimilar environments.

The aviation industry has effectively embraced standardization methods and tools to not only plan and mitigate for human error, but also acknowledge that it is unavoidable, and encourage pilots and mechanics to report occurrences. Yet, healthcare falls short of emphasizing the importance and significance of focus on standardization and process management [4]. This is somewhat due to previous standardization practices concerning medical protocols and physicians seeking to treat each patient individually. Research has shown in addition to these facts regarding standardization that medical personnel tend to deny the effects of stress and fatigue on performance and find it difficult to discuss human error in hospital settings [5]. However, it is also important to observe and understand the differences in application of standardization between healthcare and aviation. Healthcare examples thus far mostly focus and apply standardization toward the treatment of patients, and not organizational procedures or team processes. These subtle differences outline professional tendencies and history that continue to give necessary insight into understanding the overall healthcare industry culture, and how it contrasts with aviation culture.

3. Aviation Culture

The aviation industry culture has developed and strengthened around standardization and safety of processes and procedures. Both pilots and mechanics have profoundly adopted and understood the

concepts of this culture. Military aviation medical evacuation culture and commercial airline crew communication history are two valuable examples that apply to this study. U.S. Army medical evacuation and other helicopter units individually train crewmembers first, and later train those crewmembers collectively with team members and incorporate unit operations in accordance with standardized aviation training methods. The U.S. Army provides these publications to improve and sustain proficiency at all organization levels, as well as establish standards and procedures [6]. Within this standardization, crew resource management (CRM) is an exemplary tool used to mitigate communication errors and improve interaction between aviation crewmembers. Army Aviation CRM effectively cultivates an environment that places safety above experience, position, or rank; empowering any crewmember to identify potential hazards. Although subcultures may exist among non-aviator crewmembers, Army Aviation leadership at all levels place significant emphasis on establishing and maintaining positive team relationships each flight, which allows open and free communication between all crew members. These standardization and collective team concepts can be easily replicated or customized to any organization type in order to improve processes, efficiency, and overall safety.

Commercial airlines experienced a similar history of differing cultures between pilots and flight attendants. For many years, cockpit and cabin personnel were distinctly separated administratively, technically, and socially. Both groups operated independently from each other and were managed by individual departments. This separation lead to inconsistencies and conflicting information, which promoted the perception that they were two different crews instead of one [7]. Early airline experiences, and the roles of flight attendants during those times, founded the stewardess image as a service and comfort provider before an aviation crew member responsible for passenger safety. This example parallels by comparison in many ways with medical crew members in the HAA industry as being only responsible for medical services. Flight attendants at that time were not certified or licensed by the FAA; equally, medical crew members today are also not certified by the FAA, and therefore cannot be held accountable for their performance of aviation duties by the FAA [7]. Consequently, this increasingly supports the lack of intrinsic motivation and professional responsibility toward aviation duties among non-aviation professionals. One of the most difficult challenges facing the HAA industry is connected with that fact; similar to what the commercial airlines confronted, how does the HAA industry and the FAA bridge the aviation cultural disconnect between non-aviation and aviation professional disciplines? Chute and Wiener [8] (p. 213) perfectly identified and related, "the causes of the lack of communication are complex, and we caution against oversimplification. We described the problem as primarily arising from the fact that the two crews are drawn from two disparate cultures, one dedicated to and highly proficient in technical matters, particularly in the operation of complex machinery, the other well-versed in sociability and public service". This precise description of the challenges within the commercial airline crews matches in great similarity those within the HAA industry between healthcare and aviation professionals. Some of these include challenges with communication, differing authorities/regulations, and cultural differences; and while the number of passengers flight attendants are responsible for are much greater, the fixed-wing environment (airport to airport) is much more controlled/safe in comparison to the unpredictable HAA environment and flight profile.

Chute and Weiner [8] (p. 213) identified in two of their publications that a root cause to the airline industry crew communication problems is commonly related to culture. They later clarify "the two cultures, holding different values and performing different jobs aboard the same vessel, is not inherently bad. But this becomes a concern when the cultures find it difficult to communicate safety information to each other or are hesitant to do so". Therefore, this observation and industry example represents a key aspect of the professional culture disconnect aboard air ambulance helicopters; for example, medical crew members exhibit routine behavior that is best described as 'excessive professional courtesy' toward pilots, which assumes the pilot is competent and always safe, deferring to his experience and knowledge to

operate the aircraft resulting in medical crewmembers' hesitancy to communicate objective deficiencies in the pilot's performance, attitude, or threats in the observed aviation environment.

The development of CRM in the airline industry began a focus on methods and procedures to bridge these differences, and CRM has continued to evolve with technology, processes, and human behavior improvements. Within the commercial airline industry, the introduction, implementation, and leadership emphasis of CRM drastically improved the cockpit-cabin communications and collective airline crew culture, and overwhelmingly course-corrected commercial airline safety since its inception. CRM has been a catalyst in safety improvements across both military and civilian aviation that even many healthcare programs are turning to CRM training and methods within non-aviation hospital settings, such as emergency departments and operating rooms [9].

4. HAA Culture

Now that two professional cultures have been established and defined, it is accurate to infer each individual brings a unique set of experiences and history, both personally and professionally, that affect their behavior and decision-making. Overall, professional cultures have their advantages and disadvantages in terms of performance and although they are not irreversible, there is both institutional and individual resistance to change [2](p. 41). This is important to address because while we discussed professional aviation and healthcare cultures it is imperative to understand the professionals that comprise the HAA industry come from many different subcultures within each profession. To illustrate this better in relation to the HAA industry, a typical air medical transport crew consists of two healthcare clinicians, one nurse and one paramedic, and one pilot, which implies three distinct professional subculture perspectives are present.

Table 1 [5] illustrates the differences in healthcare subcultures and compares them to commercial airline pilots regarding stress and teamwork. As previously noted, this table clearly shows cultural disparities among disciplines as they relate to attitudes about errors, teamwork, and the effects of stress and fatigue on performance [5]. Although quantitative statistics were not performed, the results can still provide some insight into these results.

Responses to questions on dealing with stress and teamwork according to discipline and position. Values are numbers (percentages)

	Anaesthetic			Surgical			Intensive Care		
Item Description	Nurse (n=162)	Resident (n=80)	Consultant (n=104)	Nurse (n=175)	Resident (n=52)	Consultant (n=167)	Registered nurse (n=109)	Consultant or fellow (n=31)	Pilots (n=7558)
Even when fatigued, I perform effectively during critical phases of operations/patient care									
Agree	89 (55)	34 (57)	49 (47)	105 (60)	29 (56)	117 (70)	70 (64)	20 (64)	1965 (26)
Neutral	36 (22)	6 (10)	16 (15)	30 (17)	6 (11)	20 (12)	6 (6)	4 (13)	756 (10)
Disagree	37 (23)	20 (33)	39 (38)	40 (23)	17 (33)	30 (18)	33 (30)	7 (23)	4837 (64)
A truly professional team member can leave personal problems behind when working in the operating room/intensive care unit									
Agree	96 (59)	33 (55)	55 (53)	122 (70)	33 (63)	137 (82)	76 (70)	21 (68)	4005 (53)
Neutral	24 (15)	8 (13)	10 (10)	16 (9)	5 (10)	17 (10)	11 (10)	7 (22)	680 (9)
Disagree	42 (26)	19 (32)	38 (37)	37 (21)	14 (27)	13 (8)	22 (20)	3 (10)	2872 (38)
My decision making ability is as good in medical emergencies as in routine situations									
Agree	91 (56)	37 (61)	70 (67)	126 (72)	30 (58)	127 (76)	91 (84)	28 (90)	4837 (64)
Neutral	49 (30)	10 (17)	10 (10)	33 (19)	12 (23)	22 (13)	6 (5)	0	907 (12)
Disagree	23 (14)	13 (22)	24 (23)	16 (9)	10 (19)	18 (11)	12 (11)	3 (10)	1814 (24)
Junior team members should not question the decisions made by senior team members									
Agree	21 (13)	9 (15)	17 (16)	24 (14)	11 (21)	40 (24)	2 (2)	1 (3)	151 (2)
Neutral	27 (17)	8 (13)	10 (10)	30 (17)	11 (21)	35 (21)	4 (4)	1 (3)	76 (1)
Disagree	113 (70)	43 (72)	87 (84)	121 (69)	30 (58)	92 (55)	102 (94)	29 (94)	7331 (97)

Table 1. Responses to Questions on dealing with Stress and Teamwork According to Discipline and Position [5] (Table 1).

This table also demonstrates the significance of how individuals can affect or shape professional culture. Helmreich and Merritt [2](p. 41) summarized by saying, "The final component of professional culture that must be addressed is the personalities that members bring with them when they become socialized into professions".

Gathering these examples and understanding the two professions involved will greatly assist further efforts and research into inter-professional collaboration (IPC) within the HAA industry. Within IPC, professionals with various and specialized expertise are brought together to participate in collective decision-making in order to solve complex problems [10]. Regardless of the relationship between the individuals, organizations, or companies, inter-professional strategies to cultivate effective collaboration can be practiced. Huq, Reay, and Chreim [10](p. 522) describe these strategies as (1) promoting equality of both poles, (2) strengthening the weaker pole, and (3) looking beyond the paradox by focusing on desired outcomes. It is clear their findings and approaches for separate companies to productively accomplish inter-professional operations are rooted in a much larger perspective and common goal with both organizations' interests in mind. Inter-professional collaboration is exactly what HAA programs are attempting to accomplish on a daily basis, whether they realize it or not, and it is precisely what they need to master in order to successfully and safely collaborate together in their exceptionally unique operating environment .

Finally, the existing research and analyses of various similar and comparative environments provide substantial data from which to draw credible and informed theories as they apply to the HAA industry. However, no specific study or research was found linking the effects of different professional cultures and inter-professional collaboration to increased risk and diminished safety within HAA operations. It is the goal of this study to determine how healthcare and aviation professional cultural differences and ineffective collaboration affect the aviation safety of helicopter air ambulance operations.

5. Materials and Methods

The challenge for this study is to find a disconnect between healthcare and aviation professional cultures by examining federal agency improvement efforts, HAA industry performance and response, and HAA accident investigation outcomes that could identify evidence of consistent deficiencies in the overall safety culture within the HAA industry. To research this possibility, an archival study of HAA accident investigations over the past 20 years from the National Transportation Safety Board (NTSB) aviation database was completed. The NTSB investigative process is responsible for determining the probable causes and contributing factors without bias, and advocate and issue safety recommendations based on their findings. The NTSB Aviation Investigation Manual [11] outlines the investigation proceedings and responsibilities of the investigators, and specifically dedicates or assigns a Human Performance Group all of the individuals involved and the roles they play. In order to reliably examine potential cultural antecedents from an investigative perspective, a human error analysis approach would need to be utilized; furthermore, more than one human error investigative process should be applied to account and assess for the multiple forms of societal, professional, and organizational cultural influence.

One common investigative method is root cause analysis (RCA). Although not prescribed here, it is worth the time to briefly discuss and explain its limitations. Many organizations, especially in the healthcare industry, utilize RCA or some other representative form of this method. One such method for performing a root cause analysis is asking the "5 whys" to determine the [12] local decision that is believed to have played the greatest role or was the last event prior to the incident. At this point, the method involves asking why that occurred and keeps asking this question until you have uncovered five layers of "why" or action.

Unfortunately, like many similar tools, its popularity is not the result of any evidence that it is effective in addition to why five "layers" is sufficient. Systemic problems with this method are numerous. For example, it assumes that incidents are caused by a linear progression of events. As previously discussed, complexity science has shown that incidents are multifactorial and do not always propagate in a fashion that if A causes B, then B causes C, etc. The problem with determining a single "root cause" is that it is an ill-defined process that supports this linear notion and greatly fails to appreciate the complexity of untoward events [13,14]. It is not simple but rather simplistic in nature.

Several human error taxonomies have been developed by researchers specifically for investigating human error. Strauch cites [15] (p. 32) Neville Moray's model of error (1994, 2000) (Figure 1) depicts that human error in complex systems requires input or influence from several different elements that comprise the entire system, and all pertinent elements must be examined.

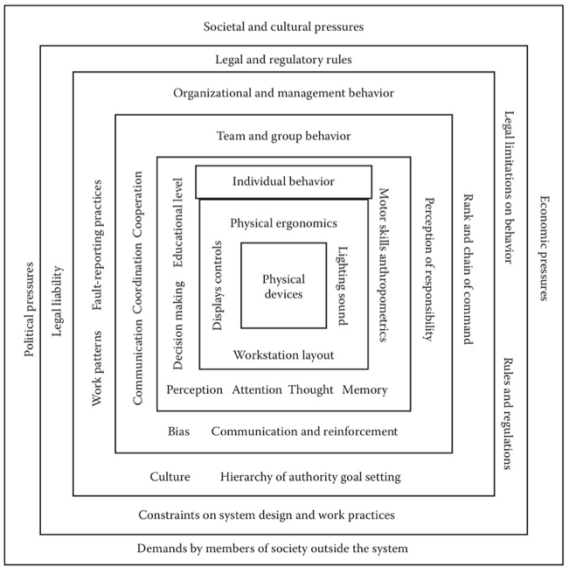

Figure 1. **Moray's Model of Error** [15](p. 32).

Moray's model particularly applies to HAA professional and organizational culture analysis due to the extremely heavy and burdensome perception our society and national culture have come to expect from emergency medical response, overall. These cultural influences impact HAA professionals frequently in many different forms, and it will require additional research to accurately determine the significance these external cultures affect the HAA industry. Strauch [16] argues that it is considerably difficult to establish cultural factors as antecedents to error, but elaborated that in order to accomplish this it requires 1) the factor must be strong enough to influence behavior, and 2) the cultural trait must be sufficiently influential to affect the particular trait [15](p. 143). Moray's model provides a technique for identifying Strauch's initial requirements.

Moray's model was considered during review and analysis of 190 aviation accident investigations from the NTSB aviation database in order to categorize final accident reports based on their findings into three general classifications 1) human error, 2) mechanical defects, and 3) weather or environmental factors; additionally, accidents that medical crew members were present in the aircraft and involved during the event were also totaled.

Further analysis of each report was recorded to reveal the extent and detail of the investigation narratives and identify whether 1) medical crew member actions during the accident were described, 2)

medical crew member experience and training was researched, and 3) the organization's actions and history documented. This supplementary examination of the investigation data regarding medical crew member actions studies the extent of inspection into the comprehensive aircraft crew and any identified differences in professional culture behavior between the pilots and the medical crew members. Moreover, it will provide a potential indication of additional extensive accident investigations in the future that include greater emphasis on helicopter crew interaction, collective decision-making, and all-encompassing human performance and behavior.

Lastly, a chronological gathering was accomplished of all known significant FAA and NTSB publications, directives, investigation recommendations, and revised regulations in order to show federal regulatory influence and impact on the HAA industry's accident and fatality rates, which they were intended to improve.

6. Results

The aviation accident reports used in the classification process were final reports only; factual and preliminary reports were not included in classification totals, but were added to total accidents and total fatalities, when applicable. As expected, accidents caused by human error overwhelmingly outnumbered the other two classifications during the 20-year span.

Figure 2 displays a timeline of the safety studies and recommendations issued by the NTSB, and the advisory circulars, directives, and regulatory changes issued by the FAA respectively. Despite the most common finding of human error, the NTSB made many recommendations throughout the industry requesting change from a whole host of perspectives. These tend to be more system wide in nature. Interestingly, these are not congruent with human error type probable cause findings. It is important to note the increase in FAA actions starting in 2004, when they were trying to keep up with the rapidly-growing HAA industry at the time. The published directives and policies addressed aircraft equipment and instrumentation requirements, crew resource management, pilot and crew training, VFR/IFR weather minimums, aircraft tracking and monitoring, operational control centers, aviation decision making, and risk assessments and mitigation. The last publication listed on the timeline, AC 135-14B (HAA Operations), specifically lobbies and emphasizes to all professional communities involved in HAA operations to improve the existing aviation safety culture within the HAA industry.

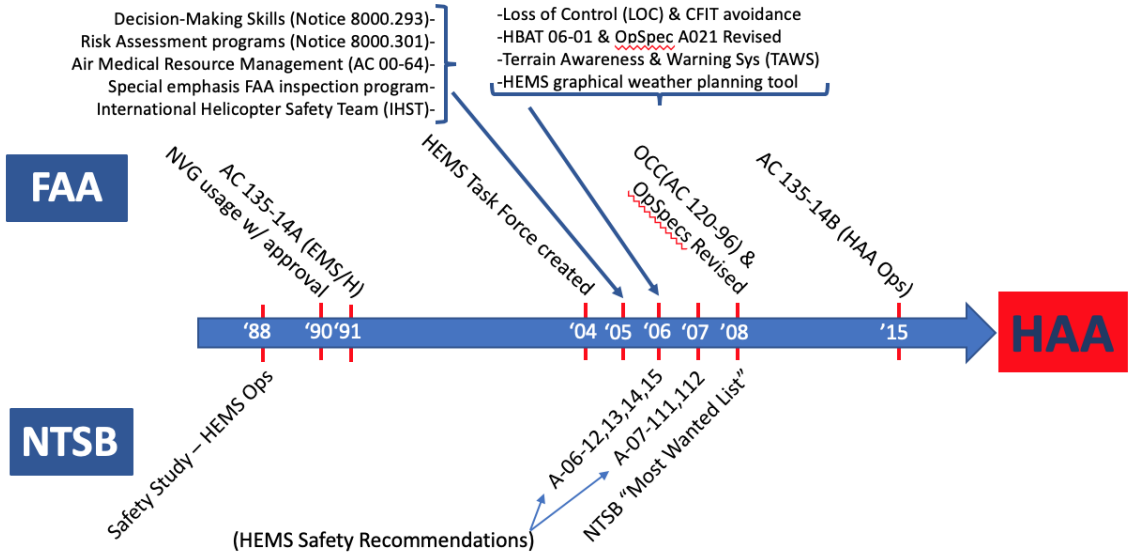

***Figure* 2. FAA and NTSB Guidance and Directive Timelines.**

Figure 3 depicts an entire 20-year timeframe, with total accidents and total fatalities by year. The horrific year of 2008, the worst in the last 20 years, is among the most referenced and brought scrutiny to a doubted industry already under a microscope. Unfortunately, even with the increased oversight and more restrictive regulations implemented by the FAA since 2006, the accident rates and fatalities have not shown a significant or consistent decline.

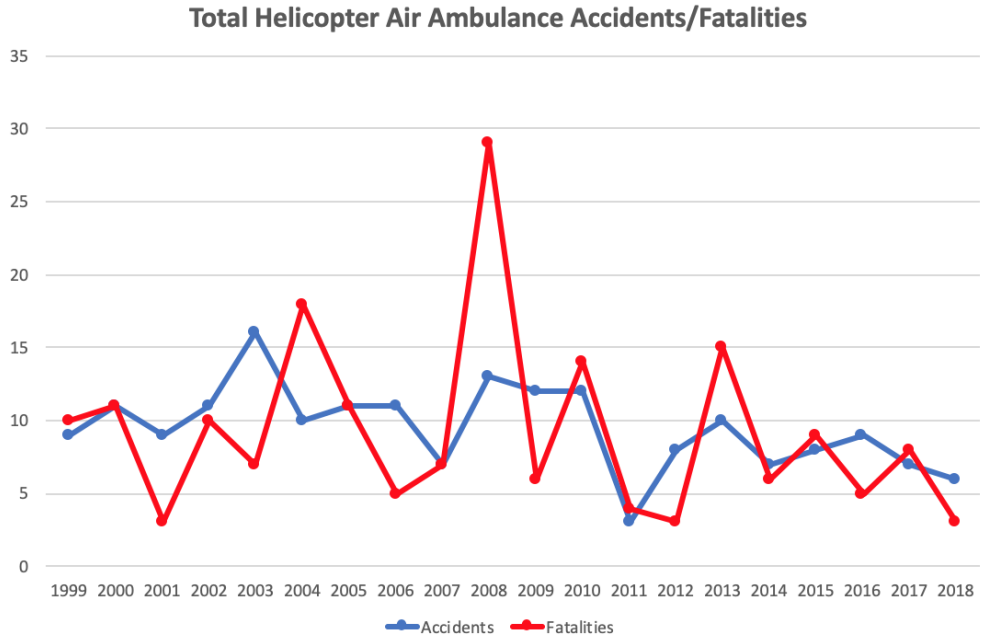

Figure 3. **20 year Total HAA Accidents/Fatalities, 1999-2018.**

Figure 4 shows the total accidents and fatalities breakdown by causation, which clearly depicts the high percentage of human error accidents, during the period of study.

Medical crew members were on board the aircraft in 94% of the 124 total accidents labelled human error events. From the 116 final NTSB accident investigations that identified human error as the cause and involved medical crew members, only 18 included crew member actions and verbal communication that occurred during the accident sequence, 17 included organizational information and background, and 6 included medical crew member history and professional experience.

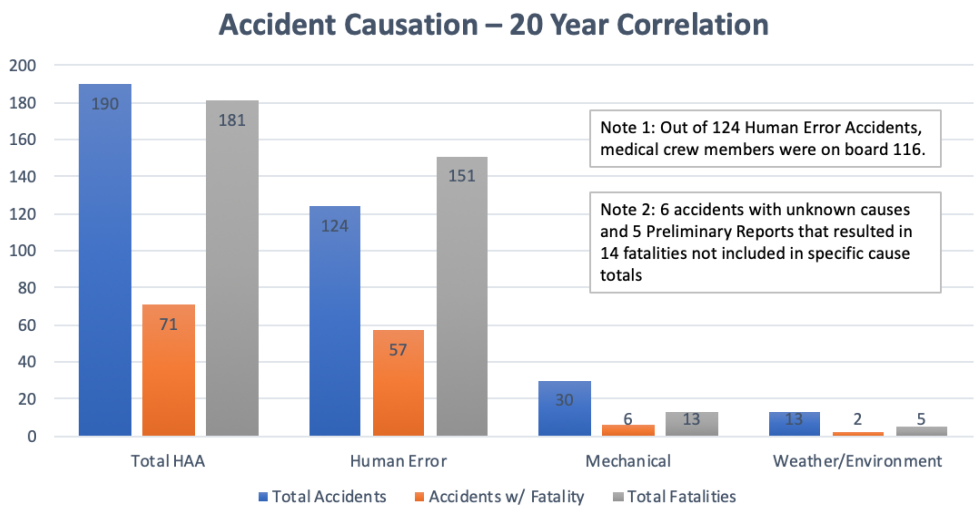

Figure 4. **Accident Causation, 1999-2018.**

The descriptions within the 18 reports that included aircraft crew interactions and communications inconclusively identifies professional culture tendencies that could inference potential contributing factors; further human performance and behavioral analysis would be needed in context to determine the effects of professional culture tendencies on the accident outcome. In an effort to begin to understand any role that conflicting cultures might have played, the local rationality of the professionals involved must be discovered. That is, not a simplistic and misguided label such as human error, but rather a better understanding of why the choices of the professionals involved made sense to them at the time. Here is where we can gain traction for better recommendations and ways to better integrate these cultures. Finally, only one NTSB final investigation comprehensively summarized and provided a section dedicated solely to 'human performance' for each helicopter crewmember, as typically conducted when utilizing a specific or dedicated human error analysis method.

7. Discussion

The Helicopter Air Ambulance safety concerns have long been identified and well documented. Consequently, the NTSB has recommended numerous changes to federal oversight and the FAA responded with dedicated and exhaustive efforts through federal policy and regulation reform over the last 10 years; however, the HAA industry has not recorded a year to date without a fatality caused by an aircraft accident attributed to human error by the NTSB. The commercial air carrier industry, which posted its safest year on record in 2017 with no fatal accidents, comparatively boasts a 0.06 fatal accident rate per one million flights worldwide [17]. The last fatal commercial air carrier accident in the United States occurred in 2009 [18]. For the HAA industry, this is the target fatality accident rate it desperately strives to achieve.

The empirical and archival evidence found from this study alone is insufficient to link the lack of collaboration between the two respective professional cultures to the problematic HAA fatal accident rate and overall poor safety record. The investigation reports commonly exposed a multitude of dormant antecedents within the 'error chain' which contributed to human error, such as environment, mode of flight, frequency or familiarity of route, unpredictable weather, unique circumstantial or situational factors, and intrinsic or extrinsic motivators and pressures; therefore, the under-emphasized cultural influences that effect individual and collective crew behavior and decision-making within unscheduled and unpredictable operations, such as the HAA industry, could provide deeper understanding and background

of these fatal accidents, other than just labeling them as 'human error'. There is nothing linear about these findings.

While the NTSB has made countless recommendations and the FAA has followed many with more restrictive regulatory changes and policy reform, very little change has been observed in the fatality rates in the HAA industry. With these changes, new equipment requirements, procedural and operation mandates, and certificate holder responsibilities have all increased or become more stringent or conservative; however, all of these changes have affected operations and procedures that only aviation service providers are held accountable for in the HAA industry, not their healthcare customers. The HAA business models will continue to remain unchanged and untouched by the FAA or the aviation industry; however, it is the aviation industry's obligation to work with those healthcare business structures and facilitate safe aviation operations. These accident investigations must include an understanding of the cultural tendencies for both aviation and healthcare so that if any differences are present they may be examined. From here, recommendations to help foster this relationship has the potential to improve the HAA accident rate, or at least a chance to make changes to prevent future accidents from any found disconnects between the two professional cultures.

There are notable differences in collaborative relationships between the respective HAA industry business types, due to their hierarchies and company structures by which the aviation provider, such as with community-based and private programs, have more scope of responsibility over personnel that includes healthcare professionals. The opportunities and ability to influence and establish change in organizational culture is greater for those programs that are composed under a single leadership structure. This leadership design and company-structured environment would indirectly and naturally promote professional cultural change between non-aviation medical crewmembers and aviation crewmembers alike. Without common standardization or regulation of non-aviation medical crewmember duties and training, as well as collective crewmember training in air medical ambulance operations, hospital-based programs will be disadvantaged and left to figure out on their own the best methods and techniques to cultivate and develop a collaborative HAA culture, or choose not to pursue that relationship with the certificate holder all together. Among three individual professional subcultures, the goal of all HAA programs should be to develop cohesion and conduct as much pragmatic collective aviation training as possible; with special emphasis on CRM and Air Medical Resource Management (AMRM).

Within the healthcare industry, there are a myriad of certifications and licensures that clinicians are required to maintain; however, there is a vast inconsistency in the standardization and requirement of aviation competency nationally for HAA medical crew members. This area needs further exploration to be better understood. Currently, the overwhelming majority of medical crew members are only required to receive special flight clinician certification for Critical Care Transport (CCT) by the hospital employers from either the Board of Certification for Emergency Nursing (BCEN) or the Board for CCT Paramedic Certification (BCCTPC). The Certified Flight Registered Nurse (CFRN) examination is comprised of 150 total questions, with 31 'general principles of transport' questions which cover only some aviation topics [19]; and the Flight Paramedic Certification (FP-C) examination is 125 total questions with only 19 aviation related questions [20]. Why does this matter for aviation? There is not an FAA standardized aviation certification process or method for medical crew members, excluding the initial training completed by the certificate holder. This provokes the question why the FAA would not pursue an aviation-specific licensure process and recurrent competence program for medical crew members, similar to the certificate of demonstrated proficiency that is required for commercial airline flight attendants. An air medical crewmember certificate or license administered and issued by the FAA could be enough to bridge the gap between the two professional cultures and foster a more unified HAA professional culture among all crew members. In order to instill a significant long-lasting transformation, all members involved need to buy into the why and reasoning for these changes; a united HAA aviation professional culture that wholeheartedly includes all healthcare and aviation professionals.

Further extensive research needs to be conducted specifically addressing healthcare and aviation professional cultures and their combined extent of influence within the different HAA business models and the consequences into varying operational safety effectiveness. There is no denying that each model brings its own unique challenges that affect personnel conducting operations. We believe that the HAA industry would be an ideal setting and work environment to conduct an inter-professional cultural research, as well as further research into greater utilization of comprehensive human error coding methods on HAA accident reports and open accident investigations. The FAA should strongly consider more standardized training, continuing education, and possibly licensure or certification of all medical crew members to ensure greater accountability and unity of effort among the entire crew member spectrum (pilots and medical crewmembers) in order to build towards a more collaborative aviation culture within the HAA industry.

8. Conclusions

It is important for the HAA industry, both healthcare and aviation members, to recognize that program leadership emphasis on teamwork and safety cultures through policies and protocols alone will not change professional culture within either healthcare or aviation disciplines, because these tools and actions establish "organizational" culture. In order to initiate significant and comprehensive "professional" culture change within an industry is to achieve an inter-professional collaborative culture, a joint HAA culture, where organizations will be required to conduct comprehensive joint professional training and stand mutually-accountable for collective standards, procedures, and techniques. The improved coordinated partnership, communication, and unity of effort between the two professions will promote and develop the new HAA professional culture.

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