Review

A rapid review of pandemic studies in paramedicine

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Abstract

Introduction

The spread of COVID-19 has challenged the paramedic community's ability to provide health care, maintain personal safety, and implement evidence informed decisions and programs. The study objective was to examine the published literature related to paramedicine and pandemics.

Methods

A rapid review of research derived from an existing broad database of literature generated between 2006 and 2019 was used. We conducted a targeted secondary search of this database to identify studies of pandemics in paramedicine contexts and included three levels of screening. We used content analysis to identify broad themes and subthemes, and provide summaries and descriptions of each.

Results

From 54,638 citations, our search identified 24 citations representing eight countries. The most common method of enquiry was cross-sectional survey (n=10). Five broad themes (and 15 subthemes) were identified: general planning and preparedness (impact to paramedic service operations, roles and responsibilities, communication centre preparedness, paramedic service preparedness, training); workforce (availability of personal protective equipment, safety of family, perception of risk, trust in the organisation); ethics (duty, resource allocation); triage (needless exposure to infection, transmission of disease); and vaccination (vaccination information, organisational readiness).

Conclusion

The evidence base describes the importance of pandemic planning and preparedness for emergency medical services and integrating these activities into broader public health and healthcare system plans. Although this rapid review provides a foundation to support response plans and research, it is considered 'just in time' for the evolving pandemic, and further work understanding research in paramedicine and pandemics is recommended.

Keywords:

paramedicine; pandemic; rapid review; emergency medical services

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Introduction

The coronavirus disease (COVID-19) was propagated by human-to-human transmission in Wuhan, Hubei province, China starting in December 2019 (1). With confirmed cases in each World Health Organization region and local transmission occurring in 66 countries, on 11 March 2020 COVID-19 was declared a pandemic (2).

Paramedic services, also often referred to as emergency medical services (EMS) and ambulance services, provide treatment and transport to those who are sick or injured in the community. Similar to other parts of the healthcare system, the availability of resources may be put under pressure and system capacity may be strained during a pandemic, especially if other large-scale events take place concurrently (eg. mass shooting, flooding). While reports regarding paramedic exposures to COVID-19 are pending, data from publications after the 2003 SARS-CoV outbreak suggests paramedics are highly susceptible to occupational-acquired illnesses, and may be the first exposed (3-6). Recent news reports have indicated that first responders, including paramedics, are acquiring COVID-19 (7).

To the authors' knowledge there are no reviews that evaluate pandemic literature in the specific context of paramedicine, although reviews were found that examine the impacts of pandemics on the health system, and one reviewed the impact of infectious diseases on paramedic health (4,8,9). Although many of the findings are generally applicable to health professions, there remains a knowledge gap in how pandemics uniquely impact paramedic services.

The capacity of paramedic services to develop and implement evidence informed programs while concurrently responding to a pandemic may be limited. Paramedic services without access to evidence databases and personnel that have both knowledge of paramedic systems, and experience in evaluating and translating evidence for health disciplines, may be particularly vulnerable to misalignment of current and best practice. Paramedic care is relatively unique compared to most other practice settings in health care, requiring specialised curation of research literature.

The purpose of this rapid review was to collect, summarise and disseminate peer-reviewed research on the topic of pandemics in a paramedicine context from a previously collected pool of studies published between 2006 to 2019, which can be used to assist paramedic services and researchers in identifying profession-specific pandemic knowledge.

Methods

This study is a rapid review of research derived from an existing database of literature generated for another broad paramedicine study. Rapid review methodology is used when

timely, quality evidence is required to inform practice related to an emerging issue, and may use techniques such as narrow question focus, simpler search strategies, restriction of grey literature, use of multiple reviewers, and simple quality appraisal to shorten the timeframe (10-12). We used content analysis to explore the database, identify broad themes and subthemes, and provide summaries and descriptions of each.

Search strategy and inclusion for rapid review

An extensive database of paramedicine literature was created as part of the search strategy for an upcoming national report. The database is comprised of both peer-reviewed and grey literature from Medline, CINAHL and Embase from January 2006 to May 2019. Search terms for that broad database included 'prehospital OR pre-hospital OR paramedicine OR para-medicine OR paramedic OR emergency medical service* OR ambulance*'.

A targeted secondary search of the database was conducted using the keyword 'pandemic'. A limitation of this database is that it contains only an article's identifying information (ie. no abstract), therefore this term was searched in the title only of candidate citations. Initial screening was conducted by one reviewer (NC) for any title containing 'pandemic' that could be related to paramedicine. Abstracts were retrieved for all included citations, then split evenly among the review team (NC, IB, JT, CH, EM) and reviewed. This second level screening criteria listed 'references EMS or paramedicine explicitly' or 'implicitly' as inclusion criteria, and 'does not reference EMS or paramedicine' as exclusion criterion. Studies that were included based on title (level 1) and abstract (level 2) underwent full text review (level 3). Full text data abstraction was performed by splitting the studies between multiple reviewers (JT, CH, EM) and confirmed by NC and IB.

To ensure that all pertinent topics were captured while still maintaining credibility of evidence, a dynamic and interactive approach to quality assessment was taken. Team members met to discuss citations based on full text review and provided input into the content of citations as well as their quality. From this discussion, it was decided that grey literature would be excluded due to the lack of overall quality, but that correspondence and abstracts would be included. Though correspondence and abstracts do not necessarily contain the data needed for a robust discussion of a theme, they do serve to validate the existence of a general theme which is further developed and understood through full text articles. This was deemed important in a subject area where little published literature exists. Discrepancies in study inclusion between reviewers were resolved through consensus.

Analysis

Qualitative content analysis was employed as it best met the study objective (13). This type of analysis allows for broad themes to be discussed, and also for a synthesis of evidence

that describes the topic as a whole. On completion of the study identification, selection and data abstraction, the review team met to discuss the entire collection, identify broad themes and ensure trustworthiness of the data and interpretation (14). Four reviewers (NC, IB, JT, CH) divided the themes and worked independently to create narrative summaries. Two reviewers (NC, IB) further reviewed the narrative summaries and full texts to create sub-themes from each theme. The compiled summaries, along with methods and discussion were then reviewed by a fifth reviewer (WT) to ensure consistency and clarity in reporting.

Results

From the database of 54,638 citations, 86 met level 1 inclusion, 59 met level 2 inclusion, and 24 level 3 or final inclusion (Figure 1). Five broad themes were represented in the data: general planning and preparedness; workforce; ethics; triage;

and vaccination (Figure 2.) A total of eight countries were represented, with 10 articles from the United States, seven from Australia, two from the United Kingdom and one each from Japan, Belgium, Canada, Switzerland and Thailand.

General planning and preparedness

There were three articles, two correspondences and two abstracts that were categorised in this theme (Table 1) (15-21). Five sub-themes emerged from these seven studies (Figure 2), which included: impact to paramedic service operations; roles and responsibilities; communication centre preparedness; paramedic service preparedness; and training.

Most studies explicitly suggested that paramedic services would be impacted by a large-scale pandemic, with some referencing the 2003 SARS-CoV epidemic and its impact on Canadian paramedics in Toronto (15,21). 'Roles and responsibilities' of paramedic services (including 9-1-1

Figure 1. Search and selection

communication centres) during a pandemic is important in the planning phase but may be incomplete (16,19). Communication centres were identified as playing an important role in the response by paramedic services to a pandemic, but not always included in planning or discussions (16). Paramedic services have some planning in place, though these may be focussed on logistics and equipment and may not include triaging patients for community-based care (16,20,21). Knowledge gaps regarding infectious diseases and roles and activities in a pandemic were identified in paramedics and senior medical students, highlighting the importance of training to increase frontline provider's willingness to work during a pandemic (17-19).

Workforce

There were four articles and three abstracts related to workforce, focussing on four connected sub-themes: availability of personal protective equipment (PPE); safety of family; perception of risk; and trust in the organisation (Table 1, Figure 2) (22-28).

Paramedics have general concern around risk and safety when working during a pandemic, and these concerns negatively impacted their feelings about attending work. Particularly, paramedic concerns regarding family safety was found in numerous studies (22,23,25,29). It was found that efforts by

organisations to prioritise staff safety, as well as clear and tangible actions to back up those messages, were key to maintaining the workforce during a pandemic. It is critical that organisations work to alleviate staff fears resulting from perceived risk and act to communicate and mitigate actual risks (24,26).

Ethics

There was one report and two articles discussing relevant ethical concerns; the report included paramedic services implicitly (Table 1) (29-31). Two closely related sub-themes emerged: duty; and resource allocation (Figure 2).

'Duty' was described as: duty to act, duty to care, and duty to self and family. Staff experience moral distress with regard to the balance between the duty to provide patient care versus protecting oneself and family (30,31). 'Resource allocation' describes paramedics' conflict between the desire to care for patients in the current state, while also recognising that many more may need care in the future. Actions taken by organisations to help mitigate other concerns and increase confidence, as discussed above, should also be helpful in reducing moral distress, which will in turn support practitioner mental health and wellness and possibly sustain a workforce both during and after the pandemic response (28).

Figure 2. Themes and sub-themes

Triage

There were two articles and one abstract that were classified as primarily focussing on the triage of potential pandemic patients (Table 1) (5,32,33). Two sub-themes were identified from these three studies, including: needless exposure to infection; and transmission of disease (Figure 2).

'Needless exposure to infection' recognises the important role that paramedic services can play in identifying patients potentially exposed or infected by a pandemic and mitigating further exposure (5). The Advanced Medical Priority Dispatch System (AMPDS) Card 36 protocol is an example of a potential dispatch triage tool, designed to identify patients calling 9-1-1 with influenza-like illness (ILI) (33). The second sub-theme 'transmission of disease' describes the prevention of disease transmission by paramedic services. This includes both the first point-of-contact and triage described above, and also incorporates the notion of a second point-of-contact and triage when paramedics arrive on-scene (5). The Pandemic Medical Early Warning Score (PMEWS) is an example of a risk management triage tool that could be used by paramedics (32).

Vaccination

There were three articles and one abstract related to vaccination (34-37). Two articles referenced paramedic services implicitly (Table 1) (36,37). Two sub-themes emerged from these studies: vaccination information; and organisational readiness (Figure 2).

The sub-theme of 'vaccination information' discussed how healthcare workers consumed information as well as the effect it had on their feelings about being vaccinated. Authors describe incomplete knowledge and misunderstanding on the risks associated with influenza and recommend practitioner targeted educational campaigns (34,35). In the sub-theme 'organisational readiness', it was suggested that most organisations were not ready to operationalise vaccination programs.

Discussion

This rapid review employed an existing database to identify 24 citations from eight countries, spanning five themes and 15 sub-themes. The 'general planning and preparedness' theme was overarching, impacting all other identified themes. The international evidence is being situated in this discussion in a Canadian context. In Canada, there is a heterogeneity of paramedic service design, ranging from systems being part of the provincial healthcare system to those overseen by any combination of municipal government, First Nations or private contractors. Some services operate their communication centre and 9-1-1 call taking, where other services may not. Therefore, a universal pandemic plan cannot be created, and local implementation will always be required.

This literature highlights areas of importance, such as clearly defined roles and responsibilities for a paramedic service (and communication centre) that is coordinated with the public health and healthcare system. Two studies in this rapid review suggest that paramedic service specific content is often not included in broader public health and health system plans, although they were conducted over 10 years ago and not based in Canada (5,16). Paramedic communication centres and emergency medical dispatchers may not always be involved in planning, yet play a vital role in pandemic response, including referral to community-based care for low-priority 9-1-1 callers and screening for ILI symptoms. Paramedics play a critical role in confirming ILI status, and especially in not routinely transporting stable patients to hospital, which includes strategies such as treating and referring patients in the community.

While triage was described as being an important paramedic service role during a pandemic, very few studies were retrieved describing pragmatic tools and description of training for paramedics and emergency medical dispatchers to this end. Even with rigorously validated tools, 9-1-1 call triage processes are dependent on the quality and accuracy of information being provided, and paramedic on-scene triage processes must be readily employed in heterogeneous situations over short timeframes. Paramedics should be equipped with tools to appropriately assess, treat and refer patients, especially in identifying patients at high risk of complications. These activities portend considerable patient safety risk, and increased medico-legal risk for paramedic services and paramedics. In addition to training, appropriate quality assurance, including performance feedback, and senior paramedic and physician oversight should be anticipated and employed. Consideration should be made to including these activities into formative paramedic development documents, such as the Canadian Paramedic Profile by the Canadian Paramedic Association, and Paramedic Chiefs of Canada Vision document (38).

Additional triage responsibilities may add to the perceptions of personal and family risk. There is evidence that paramedics do not feel they are well trained or prepared for pandemics, and also evidence that training and education can improve confidence in paramedics to appropriately respond in a pandemic (17,18). Clear communication around the availability and use of PPE, accurate information about risks, and programs targeting practitioner safety and triage decision support may serve to decrease the actual and perceived risk. Ethicists warned that the traditional concept of duty to care, which rests on the assumption that healthy providers are bound morally by commitment to their patients, could be insufficient in a time of crisis such as a pandemic. It is unclear that this duty would hold up in the face of significantly increased risk, be it perceived or actual (39).

The five themes and 15 sub-themes that have been identified in the literature, while presented separately, in reality should

be considered as having a complex relationship. 'General planning and preparedness' appears to be critical in influencing the other themes such as workforce; ethics; triage; and vaccination. All themes tie together to bolster staff and public confidence that paramedic services are ready for multiple scenarios that may require different and novel approaches. As strategies are developed and initiatives implemented, training should not be underestimated, both in terms of preparing paramedics clinically and operationally, but also to build personal confidence, confidence in the organisation and improved performance. Finally, the role that paramedic services play should not be underappreciated; triage decisions and assessments made at the time of the 9-1-1 call and on-scene have important implications for how a healthcare system will respond and fair in a pandemic.

This study was intended as a rapid review of the literature for prompt dissemination to paramedic service leaders and researchers who are in the throes of responding to the COVID-19 pandemic. The results of this study should not be viewed as systematic, and the reviewed studies and resulting themes not considered exhaustive, but rather as a starting point for further literature searching and understanding. While every effort was made to ensure unbiased inclusion and quality data abstraction, the methods used are not as rigorous as typically employed in a systematic review. With a more thorough review and curation of the full body of evidence, research focus may be required on diversions, hospital offload delay, 9-1-1 call and paramedic on-scene triage and referral to community-based services, clinical practice changes, training and experience and the range of roles that may not be captured in existing paramedic documents, such as high-risk response teams.

Conclusion

This rapid review identified 24 citations related to pandemics and paramedicine that incorporated five broad themes, including: general planning and preparedness; workforce; ethics; triage; and vaccination. A further 15 sub-themes were identified, that describe the importance of pandemic planning and preparedness for paramedic services and integrating these activities into broader public health and health care system planning. As this review is considered 'just in time' for the evolving situation with COVID-19, further work understanding and contributing to the research literature related to pandemics and paramedicine is recommended. This review highlights the greater need for specialised knowledge production and use in order to drive innovation and change in paramedicine.

Competing interests

The authors declare no competing interests. Each author of this paper has completed the ICMJE conflict of interest statement.

Author contributions

All authors contributed to the study's conception, design and/or acquisition of data and/or interpretation of data, and each has given substantial input to successive revisions of the manuscript. We had full access to all the study data and we assume responsibility for the integrity of the data and the accuracy of the analysis. The individual author contributions are as follows: N Cavanagh: initial concept, study design, search, title and abstract review, full text review, analysis, manuscript preparation; IE Blanchard: initial concept, study design, title and abstract review, full text review, analysis, and manuscript preparation; J Taplin: title and abstract review, full text review, data abstraction, analysis, and manuscript preparation; W Tavares: study design, and manuscript preparation; C Hall: title and abstract review, full text review, data abstraction; D Weiss: initial concept and manuscript preparation.

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Table 1. Summary of included studies listed by theme and year of publication

Studies that reference EMS or paramedicine explicitly						
Author	Year	Country	Article type	Methods	Sample size	Results and conclusions
General planning and preparedness						
Oliver AL, et al	2012	US	Correspondence	Cross-sectional survey	56/56 (100%) US states, territories and DC	<p>Evaluated compliance with federally mandated guidelines for pandemic preparedness. Plans defining the role of EMS and 9-1-1 in the preparation, mitigation and response to pandemic were most often incomplete. Found that a minority (13.3%) of assessed states included communication centres in pandemic planning. Communication centres minimally addressed statewide mechanisms for updates or protocol changes. The coordination of these changes with other 9-1-1 systems, and the dissemination of rapid updates to pandemic influenza symptom sets was not adequately addressed, many systems did not have process and protocols that guide 9-1-1 triage and patient classification, limiting their ability to direct patients to alternative care pathways. The development of a plan for paramedics to treat and refer patients to other health services without transport to a healthcare facility was not commonly addressed in US systems, and may require changes to legislation in many jurisdictions. Most EMS agencies had not planned for isolation and quarantine of infected paramedics, with potentially serious consequences on workforce and resource availability.</p> <p>This study did not demonstrate a sizeable impact from the H1N1 outbreak. The two reported impacts were an increase in the mean interval between EMS call and arrival at hospital in the post-H1N1 period, compared to the pre-period (31.3 and 28.8 minutes respectively; $p<0.001$) and an increase in the time at hospital (described as the 'sojourn' time) between the post- and pre-H1N1 periods (17.0 and 14.0 minutes respectively; $p<0.001$). Authors point out the obvious limitations in this small retrospective analysis, and also the differing impact that virulence may have on EMS operations, suggesting results may have differed with another virus such as H5N1.</p>
Tsubokura M, et al	2010	Japan	Correspondence	Retrospective descriptive analysis	961 patients	<p>Frontline medical response may be significantly impacted by paramedic absenteeism. May be motivated by anxiety or concern about working during pandemic conditions. Suggests this could potentially be mitigated by education and training to maximise preparedness. While 47% of paramedics reported they had received adequate training, only 25.7% had high knowledge of general influenza, 5.1% of avian influenza, and 42.1% of infection transmission. Perceived adequateness of training may also have an impact on the willingness of paramedics to work during a pandemic. Those paramedics with perceived adequate training were less worried about working during a pandemic than those whose perception their training was incomplete (OR=0.62; 95% CI 0.5-0.8).</p>
Watt K, et al	2010	Australia	Article	Cross-sectional survey	725/2929 (24.7%) participants	<p>The didactic and skill-building training was effective in increasing knowledge of the influenza virus, proper use of PPE, agency policies, and seasonal influenza vaccination, at least in the short term, and in changing behavioural intention. The 30-minute training program focussed on infection control, donning and doffing of PPE and departmental policies. Specifically, knowledge of criteria for flu-type emergency calls increased from 42% to 52%, when to don PPE increased from 72% to 91%, behavioural intention to wear an N95 mask increased from 76% to 84%, intention to receive the seasonal influenza vaccination increased from 45% to 52%, confidence in PPE increased from 69% to 84%, and confidence in having the knowledge to protect themselves during avian influenza increased from 72% to 93% (all $p<0.001$).</p>

Table 1. Summary of included studies listed by theme and year of publication (continued)

Studies that reference EMS or paramedicine explicitly					
Author	Year	Country	Article type	Methods	Sample size
General planning and preparedness					
Mortelmans LJM, et al	2009	Belgium	Article	Cross-sectional survey	243/810 (30%) participants
Hall D	2007	Australia	Abstract	Unspecified 'project management methodologies'	Not provided
Higgins J, et al	2007	Australia	Abstract	Survey and focus group	Not provided
Workforce					
Roberts KA, Bryce E	2015	Canada	Abstract	Cross-sectional survey	13 participants
Barnett DJ, et al	2010	US	Article	Cross-sectional survey	586 participants, RR=49%
Tippett VC, et al	2010	Australia	Article	Cross-sectional survey	725 participants

Senior medical students showed high level of willingness to assist in care of avian influenza patients, despite limited education. Students were more cautious when patients were children. Further education for medical students, and a legal base and ethical guidelines should be provided. Only 22% reported being aware of the plan to be redeployed during a pandemic.

As stated in Hall project outcomes have included the following: engaging the workforce; acquisition, distribution and allocation of respirators to operational staff; training programs; stockpiling of infection control consumables; detailed logistics for pandemic equipment and supplies; development of surveillance and early warning capabilities; and development of robust command and control procedures.

Preliminary results suggested emphasis is placed on ensuring that high levels of safety through information exchange is achieved. Priority topics as stated in Higgins include personal protective equipment, new operational standards and communications strategies for working in infectious disease environments.

Paramedics surveyed regarding confidence and concerns working during a future pandemic. PPE compliance and knowledge of infection control and prevention varied amongst practitioners. Over 80% of paramedics would report to regularly scheduled shifts. As stated in Roberts and Bryce, barriers to willingness to work included concerns over family safety (34%), personal safety (24%), lack of confidence in employer's preparedness (20%) and lack of PPE availability (19%).

Participants presented with hypothetical influenza pandemic scenarios and asked about willingness to work. Over half (52%) of paramedics would not report to work if they perceived risk of disease transmission to family; 93% would report to work if required to do so. Hazard-specific practitioner education increased the likelihood of voluntarily reporting to work. Study strongly recommends personal and family preparedness.

Investigated potential association between knowledge and attitudes of influenza and likely personnel behaviour. Over half of respondents reported an unwillingness to work during a pandemic. Identified lack of confidence in employers' ability to respond and poor relationship between partners/staff. Fear for safety for themselves and their families was a common theme. Education and training needs to address concerns regarding relationships and confidence in organisation and partnerships. Paramedics perceived increased risk to themselves when they felt there was a lack of organisational preparedness. The potential inadequate preparedness was observed through factors such as inadequate or inconsistent communication, and uncertainty about continued availability of PPE and when to use it.

Table 1. Summary of included studies listed by theme and year of publication (continued)

Studies that reference EMS or paramedicine explicitly						
Author	Year	Country	Article type	Methods	Sample size	Results and conclusions
Workforce						
Mackler N, et al	2007	US	Article	Cross-sectional survey	95 participants	Without protection against infectious disease including vaccination and PPE, majority of paramedics would not remain on duty. Despite being fully protected, 38% of participants would not remain on duty if their immediate family was not protected, compared to 91% if their family was protected. Suggest pre-pandemic planning that includes stockpiling of PPE, vaccinations, and increased availability of antivirals would improve workforce participation. Suggested that first-responders who feel their safety is prioritised by employer are more likely to come to work.
Tippett V, et al	2007	Australia	Abstract	Research proposal	N/A	Abstract outlining consultative and methodological approach to research around paramedic perception of risk in a pandemic. No results reported.
Watt K, et al	2007	Australia	Abstract	Cross-sectional survey	Not reported	Preliminary results indicate high perception of risk among paramedics due to a lack of confidence in adequate strategies to mitigate exposure risk during a pandemic. Identified strategies to address risk includes confidence in PPE and communications.
Ethics						
Stratton SJ	2010	US	Article	Editorial	N/A	Study from UK reports absenteeism could be as high as 85% based on reported willingness to work surveys. Unwillingness based on distrust of government and employer to keep staff and their families protected and supported. Staff may choose to be absent due to unacceptable risk to self and/or family. Logistics, remuneration, psychological and legal support identified as a way to help remove barriers to willingness to work. Despite identified concern, government officials and healthcare organisations have done little to address issue. Description of ethical dilemma faced by healthcare workers of job obligation versus personal and family safety. Currently healthcare worker duty-to-care is not defined. States the model of duty-to-care assumed by many ethicists and planners is inadequate as the risk of infection is high, as seen in the 2003 SARS-CoV outbreak. If it was perceived that personal risk was too great, there were no strong professional guidelines on ethical duty that would help ground the decision to still attend work.
Simonds AK, Sokol DK	2009	UK	Article	Review	N/A	Practitioners presented with competing duties that include: patients, oneself, family, colleagues, and society. Professional associations define the duty to act differently. As stated in Simonds and Sokol 'Physicians should balance immediate benefits to individual patients with ability to care for patients in future'. Risk of infection is heterogeneous across professions and proximity to patients; paramedic and community teams identified as higher risk due to frequent exposure outside of hospital. Studies discussed found majority of practitioners felt duty to act despite infectious patients putting them at risk; real-life practice and hypothetical scenarios are likely divergent. Communication between stakeholders critical to address concerns, misunderstandings and fears regarding transmission and risk. Gap between actual risk and the perception of risk should be addressed.

Table 1. Summary of included studies listed by theme and year of publication (continued)

Studies that reference EMS or paramedicine explicitly					
Author	Year	Country	Article type	Methods	Sample size
Triage					
Gray JT, et al	2010	UK	Article	Retrospective descriptive analysis	300 patients
<p>The PMEWS provides a tool to manage risk in the pre-hospital setting. This study assessed the correlation between ECP decision to admit to hospital or leave the patient at home. (NB: an ECP is a paramedic or nurse with an additional 12 months of training) and PMEWS score. 300 patients were included in the study, with 98 (33%) requiring hospital assessment or admission. While the authors did not explicitly provide quantitative summary measures of agreement between PMEWS and ECP transport decision, the authors conclude that this score 'correlates well' with ECP transport decision outcomes.</p>					
Pierog JE, et al	2010	US	Abstract	Retrospective descriptive analysis	57 patients
<p>Describes a case series from a single county dispatch system, where 764 out of 9729 patients were classified as Card 36. Of the 57 patients followed-up on arrival at a single site, only five had a subsequent ED diagnosis consistent with ILI. Moreover, 34/57 (60%) required admission, with the following determinants as stated in Pierog et al: Omega 7/12 (58%), Alpha 11/13 (85%), Charlie 5/9 (56%) and Delta 13/19 (68%). Out of 57, two were diagnosed with acute MI (including one STEMI), and one was admitted to ICU for respiratory failure. The authors concluded that in their system Card 36 poorly risk stratified ILI patients.</p>					
Bielajs I, et al	2008	Australia	Article	Literature review and development of a triage management protocol	Not applicable
<p>From Bielajs et al 'The lack of disease-specific triage-management protocols that address the unique aspects of a pandemic places emergency medical services, and specifically, emergency medical services practitioners, at great risk. Without adequate protocols, the emergency health system will risk needless exposure, loss of functional capacity, and inappropriately triaged patients. This paper reports on the development of population-based triage management protocols at two patient points of contact. The primary objective of the triage-management protocols is to identify patients infected by or exposed to the biological agent, and consequently, appropriately triage patients so as to optimise the utilisation of emergency medical services and surge capacity resources through disposition and care at hospital- and non-hospital-based care facilities. Protocols must include standardised 'flu questions' and a fear and resiliency checklist to ensure protection and separation of the susceptible population from those infected or exposed'.</p>					
Vaccination					
Moser A, et al	2016		Article	Cross-sectional survey	62
<p>42% of EMS practitioners had seasonal influenza vaccination; rate higher (60%) with pandemic influenza vaccinations. Suggest that there is incomplete knowledge and misunderstanding on the risks associated with influenza. Majority of vaccinated practitioners stated that protection of close family and friends was their primary motivation for vaccination. If practitioners refused vaccination, they were required to wear surgical masks when interacting with patients; suggested that there would likely be poor compliance with this policy. EMS worker vaccination rates were lower than other healthcare workers.</p>					
Chotpitayasunondh C, et al	2011	Thailand	Abstract	Cross-sectional survey	683
<p>Majority (57%) of healthcare workers surveyed on vaccinations were paramedics; 84% regarded vaccinations as effective, 60% willing to be vaccinated. Vaccination information frequently gained from mass media, recommended to make vaccination information more readily available to increase vaccination rates. The most common reason to refuse vaccination was the potential of side effects from the vaccination, and the majority of vaccinated practitioners stated that protection of close family and friends was their primary motivation for vaccination. To increase vaccination rates it is essential to have correct and updated information presented by mass media.</p>					

Table 1. Summary of included studies listed by theme and year of publication (continued)

Studies that reference EMS or paramedicine implicitly					
Author	Year	Country	Article type	Methods	Sample size
Workforce					
Perrin PC, et al	2009	US	Article	Report	N/A
Emphasises the importance of healthcare worker psychological wellbeing during a successful response to crisis. Mental healthcare planning is essential to public health preparedness for infectious outbreaks. Plan includes both public health relief and recovery. Discussion on the dilemma of the healthcare worker to provide care and protect family, leading to worsening psychological effects. Highlighted 'importance of assuring that personnel have: good understanding of risk scenario; confidence that the organisation will provide appropriate protective equipment, timely information, and psychological support; belief in having been well trained to cope with emergency responsibilities, including ability to communicate risk to others; and perception that their personal roles within the settings are important'. Enhanced mental health surveillance is recommended, includes elements similar to mental health first aid.					
Ethics					
Pena ME, et al	2009	US	Article	Report	N/A
Identifies ethical challenges that emergency care providers face during a pandemic. Emergency care providers will encounter infected and non-infected patients and be involved in critical decisions. Balance of utilitarian caring for the greatest number of patients with protecting individual patient rights and liberties. Necessary for emergency providers to have adequate representation in pandemic planning and resolving ethical issues.					
Vaccination					
Moulia DL, et al	2017	US	Article	Review	N/A
Assessment of readiness to vaccinate Centres for Disease Control funded critical infrastructure personnel (CIP) in influenza pandemic. 43.3% reported plan to vaccinate. However, 41% unable to provide estimate of staff needed to administer vaccines. Concluded many health programs not organisationally ready to vaccinate CIP during pandemic. More effort required to ensure and track public health readiness. Research on barriers to vaccinate required. While this was not a paramedic specific study, emergency services were included as a part of CIP requiring the first wave of vaccinations. The authors conclude that further research on barriers to vaccination and more effort to ensure and track public health readiness is required.					
Hoffman MH	2010	US	Abstract	Retrospective descriptive analysis	57 patients
Describes a case series from a single county dispatch system, where 764 out of 9729 patients were classified as Card 36. Of the 57 patients followed-up on arrival at a single site, only five had a subsequent ED diagnosis consistent with ILI. Moreover, 34/57 (60%) required admission, with the following determinants as stated in Pierog et al: Omega 7/12 (58%), Alpha 11/13 (85%), Charlie 5/9 (56%) and Delta 13/19 (68%). Out of 57, two were diagnosed with acute MI (including one STEMI), and one was admitted to ICU for respiratory failure. The authors concluded that in their system Card 36 poorly risk stratified ILI patients.					