Paramedic Evidence-Based Practice (PEP)
Paramedic Critically Appraised Topic (CAT)

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Title: Basic infection control knowledge and adherence in primary care paramedics

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Clinical Scenario:

Two primary care paramedics are attending a medical cardiac-arrest in a home. The only other person within the home (the person who called 911) is a new partner of the patient who does not know much about their past medical history. While on this call, the primary paramedic gets a small but significant amount of the patient's blood on the sleeve of their uniform sweater. As the patient is VSA and unresponsive the paramedics have no knowledge of the patients infection status and may not know of any risks present to them until hours or days later. As they work quickly, the primary paramedic does not realize he has acquired this blood on his uniform and proceeds to work on the patient in the home and then in the back of the ambulance. The paramedics sleeve makes contact with the bench, shelves, and other equipment in the back of the ambulance. The paramedic uses designated cleaning wipes for the common surfaces once the call is completed but the ambulance does not receive a deep clean before the paramedics move on with their next call. The paramedic also does not remove his sweater for the remainder of the shift.

This scenario only depicts risks associated with blood-borne infection, but other scenarios could just as easily depict similar concerns over direct contact with other infected bodily fluids, respiratory/airborne infections, contact with contaminated fomites or the presence of vectors. This scenario also specifically depicts only a portion of the "Standard Precautions for All Patient Care" that are provided by the Centre for Disease Control (CDC). A number of other scenarios could depict a variety of other dangers presented by a lack of knowledge of infection control basics within primary care paramedics.

PICO (Population - Intervention - Comparison - Outcome) Question:

Would standardized, ongoing education and training of primary care paramedics on infection control basics ("Standard Precautions for All Patient Care" as per the CDC), as opposed to current non-standardized practices, allow PCPs to better maintain the safety of both themselves as well as their patients while on shift?

Search Strategy:

(paramedic OR emergency medical technician OR emergency medical service OR emt OR ems OR ambulance OR prehospital OR pre-hospital OR emergency service OR first responder OR field triage OR out of hospital) AND (infection control OR infection prevention OR cross infection OR disease transmission OR universal precautions OR standard precautions OR standard precautions in infection control OR equipment contamination OR contamination OR infectious OR infectious disease OR communicable disease) AND (guidelines OR protocols OR protocol OR practice guideline OR clinical practice guideline OR policy OR policies OR guideline adherence) AND (knowledge OR education OR training OR understanding OR awareness OR perception)

Limits: last 5 years, English language

Search Outcome: 188 results (52 CINAHL, 136 MedLine)

Relevant Papers: 3 papers were chosen as relevant for this CAT (based on direct measurement and discussion of infectious agent presence and transfer within EMS)

Author, Date	Design (LOE)	Population	Intervention & Comparison	Outcomes Measured & Results	Strengths & Weaknesses
Valdez, Sexton, Lutz & Reynolds (2015) (Spread of infectious microbes during emergency medical response)	Small RCT LOE 2	Fire engines and rescue trucks at 1 Northwest Fire District fire station in Tucson, Arizona. Fire engines and rescue trucks utilized in real EMS calls were observed and sampled. Employees observed included firefighters and firefighter paramedics.	**Intervention:** Decontamination of fire engines, rescue trucks and equipment within utilizing activated hydrogen peroxide wipes (chosen for safety of use on delicate equipment). Employees were instructed on how to use wipes and were told to "wipe down all surfaces and equipment they remembered using during a call". **Comparison:** Decontamination of fire engines, rescue trucks and equipment within as per current practices. This was not standardized, techniques and supplies used varied from employee to employee.	**Outcome Measure:** Prior to the beginning of sampling 2 pre-determined frequently touched surfaces were seeded with ΦX174 (a bacteriophage tracer), the LIFEPAK handle and EPCR handle. Seeding was then maintained every hour until an EMS call was received. After seeding neither surface was handled by employees prior to the beginning of an EMS call. Resultant viral loads were then measured on both surfaces prior to EMS calls (negative control) and again after EMS calls. Additional non-seeded, surfaces of interest (LIFEPAK keyboard, EPCR touchscreen/keyboard, MDT touchscreen/keyboard, portable radio, headphones, inside cab, jump bag handle, glucometer) were also sampled before (negative control) and after EMS calls to measure transfer. After EMS calls measurements were split into 3 phases (Phase 1: pre-decontamination Phase 2: post-decontamination per current practices Phase 3: post-decontamination per activated hydrogen peroxide wipes). In each phase 58 surface samples were taken pre- and post-EMS call from the 2 seeded sites (n=10) and across 13 non-seeded sites in fire engines and 12 non-seeded sites in rescue trucks (n=48). In each phase 5 EMS calls were observed (3 in fire engines, 2 in rescue trucks). **Results:** **Phase 1:** Mean ΦX174 load of 1.59 (±1.98) x 10^6 PFU before EMS calls and 1.89 (±2.81) x 10^5 PFU after EMS calls. **Phase 2:** Mean ΦX174 load of 2.03 (±1.86) x 10^6 PFU before EMS calls and 8.37 (±7.43) x 10^5 PFU after EMS calls. *Decontamination per current practices did not significantly reduce viral loads compared to pre-decontamination (p=0.2113).* **Phase 3:** Mean ΦX174 load of 2.93 (±4.35) x 10^6 PFU before EMS calls and 8.14 x 10^4 (±2.26 x 10^5) PFU after EMS calls. *Decontamination with activated hydrogen peroxide wipes significantly reduced viral loads compared to pre-decontamination (p=0.0065) and compared to current practice decontamination (p=0.0009).* **Overall:** *Cross contamination of non-seeded surfaces and equipment occurred in all 15 EMS calls. Cross contamination was present on 56% of non-seeded surfaces (27/48) pre-decontamination and 54% (26/48) and 40% (19/48) of non-seeded surfaces following decontamination per current practices and activated hydrogen peroxide wipes (trained intervention) respectively.*	**Strengths:** -Medics were blinded to which surfaces would be sampled minimizing information bias -Researchers observed medics for several weeks prior to beginning of sampling reducing the Hawthorne Effect -ΦX174 cannot infect human cells, allowing this study to safely utilize real EMS calls and real patients **Weaknesses:** -Only 1 fire station was observed -Phases 1, 2 & 3 were performed on different dates, allowing the possibility of confounding variables being present -only hard, non-porous surfaces were sampled (soft, porous surfaces may present unique challenges) -Because surface areas sampled were not equal direct comparison of contamination per unit surface area could not be done -ΦX174 may cause over- and under-estimations of certain types of pathogens -Though published in 2015 the experiment was run in 2012, potentially outdating the results

Author, Date	Design (LOE)	Population	Intervention & Comparison	Outcomes Measured & Results	Strengths & Weaknesses
Wepler *et al.* (2016) (Prevalence of no-socomial pathogens in German ambulances: the SEKURE study)	Prosp-ective Cohort Study LOE 3	Ambulance vehicles from 56 (of 78) rescue stations across Germany. All 78 stations across Germany were eligible and contacted, only 56 participated. Both "emergency ambulances" and "patient transport ambulances" were sampled.	**Intervention:** No intervention. **Comparison:** Samples from both types of ambulances and across all 56 participating rescue stations were compared and given a score based on colony forming units (CFU) of microorganisms per agar plate ($24cm^2$) and absence or presence (and number of detections) of MSRA or Methicillin Resistant *Staphylococcus aureus*. These scores were then assessed for any correlation with factors examined on a standardized questionnaire (completed at the time of sampling by EMS personnel on duty) including: number of annual calls received, qualifications of personnel, hygiene procedures in place and frequency of cleaning and disinfection of the ambulances.	**Outcome Measure:** Agar plates were used to assess microbial load (CFU) of samples. Sampling points in ambulances were selected based on how frequently they were used. Points chosen were: glove packaging, carrying handles (cardiovascular bag, airway bag), stretcher handles, stretcher headboard, O2 sats clip, oxygen hose, ECG cables, ECG panel, BP cuffs, tourniquets, ceiling flap, compartments/cabinets (intubation, syringe, heat, pharmacist). Some of these sampling points were chosen specifically because they were routinely ignored during cleaning and disinfection. This was done in both "emergency ambulances" and "patient transport ambulances". During each sampling visit EMS personnel on duty at the time also competed a standardized questionnaire regarding number of calls per year received by that station, qualifications of the station personnel, hygiene procedures in place for that station, and the frequency and method of ambulance cleaning and disinfection. **Results:** **Agar Plates:** -2,136 samples were collected from 150/225 ambulances at the 56 stations. -Only 124 samples were sterile (5.8%). -Surfaces in direct contact with patients and staff had the highest scores i.e. highest contamination (based on microbial loads and whether or not the agar plates contained MRSA), these included carrying handles, the stretcher, ECG cables, ECG panels, BP cuffs and O2 sats clips. -More surfaces were contaminated in "emergency ambulances" and with higher CFU and more detections of MRSA. -Types of microorganisms detected were: spore formers, environmental moulds, Aspergillus, Pseudomonas, Corynebacteria, Micrococci, Streptococci, Coagulase Negative Staphylococci, Staphylococcus aureus and MRSA. **Questionnaires:** -Only 49 of the 56 stations sampled completed the questionnaire (88%). -Using the Spearman correlation coefficient, no significant correlation was found between level of microbial load and the number of calls received by the station per year ($p=0.5942$ for emergency ambulances and $p=0.4364$ for patient transport ambulances). -Using Fisher's exact test non-random associations were not found between and of (i) the presence of specially trained personnel, (ii) the frequency of ambulance disinfection or (iii) the type of disinfection practiced and the detection of MRSA ($p=1.00$ for all three).	**Strengths:** -72% of all of Germany's rescue stations were sampled, providing data from across the country. -Visits to stations for sampling were made 2 months after consent had been obtained and were unannounced to prevent a bias in anticipating visits. -Sampling was done at different times of day with different personnel on duty. **Weaknesses:** -Geographical spread of the 72% of rescue stations was not given. -Definition of "emergency ambulance" vs "patient transport ambulance" was not explained, whether or not both types were sampled at each station was also not explained. -How sampling surfaces were chosen was based on frequency of use and disinfection but how did they determine this (through observation?) -Whether or not personnel were aware of which surfaces would be sampled was not clear. -Who completed the questionnaires was not clear (a supervisor or the paramedics?) -Questionnaire items were unclear in their reasoning: did qualifications of personnel refer to level of care training or their knowledge of infection control? Were "hygiene procedures" referring to the practices of the paramedics (hand hygiene etc) or something else (cleaning of the station etc)? -No statistical analysis was offered evaluating association between the hygiene procedures in place at the station and the contamination scores for that station.

Author, Date	Design (LOE)	Population	Intervention & Comparison	Outcomes Measured & Results	Strengths & Weaknesses
Orellana *et al.* (2016) (Methicillin-resistant Staphylo-coccus aureus in Ohio EMS providers: a statewide cross-sectional study)	Prosp-ective Cohort Study LOE 3	280 EMS personnel from 84 agencies across Ohio were sampled (swabbed for MRSA) and given a questionnaire. The 84 agencies were randomly selected (and all agreed to participate) from both urban and rural agencies across all 10 EMS regions of Ohio (20 strata). At least 1 agency from all 20 strata was sampled. Personnel on duty at the time of unannounced sampling visits were utilized.	**Intervention:** No intervention **Comparison:** No comparison	**Outcome Measure:** Nasal carriage of Methicillin Resistant *Staphylococcus aureus* (MRSA) was measured in 280 personnel via nares swab. At the time of swabbing, personnel also completed a self-administered anonymous survey evaluating possible risk factors for MRSA exposure and carriage. Questionnaire included: demographics (age, race, gender), occupational history (EMS certification level, years in EMS), hygiene practices (method and frequency of hand washing), health status (heart disease, diabetes, open wounds), prescription antibiotic or immunosuppressant use, presence of any cohabitants (someone working in healthcare, someone with recent staph infection (<1 year), antibiotic use or hospital admissions), and whether or not razors, towels, or workout equipment were shared with these cohabitants if present. **Results:** -Sample was predominantly non-Hispanic white (99.3%), male (87.9%), in an urban setting (64%), working more than 40 hours per week (85.3%), with ALS certification (72%), and less than 16 years experience (63.6%). On average 36.9 years of age. **Population Results:** -13/280 (4.6%) were positive for MRSA. Note: MRSA prevalence in the general population is known to be 1.5-2%. -(A) Those who reported presence of any open wounds (lesions, boils, infections) were 6.75x more likely to carry MRSA (95% CI, 1.25-36.36)(p=0.0262) -(B) Those who did not wash their hands frequently after glove removal (sometimes, rarely, or never) were 5.18x more likely to carry MRSA (95% CI, 1.5-16.92)(p=0.0065). -(C) Those who washed their hands less frequently during a shift (fewer than 8 times) were 3.42x more likely to carry MRSA (95% CI, 1.08-10.75)(p=0.0360). **Survey Weighted Results:** -Estimated that 1,965 (4.4%) of Ohio EMS personnel carry MRSA. -(B) As above, 10.51x more likely to carry MRSA (95% CI, 2.45-43.45)(p=0.0012). -(C) As above, 4.20x more likely to carry MRSA (95% CI, 1.02-17.27)(p=0.0468). -(D) Those who reported cohabitating with someone with a staph infection were 9.02x more likely to carry MRSA (95% CI, 1.03-78.98)(p=0.0470).	**Strengths:** -All 10 EMS regions within Ohio were represented. Each region had at least 1 urban and 1 rural agency sampled. (Probability sampling with geographically stratified cluster design). -No participants ended up excluded as all were swabbed and all completed the questionnaire. -Statistical analysis was thorough. -Survey weights were used to ensure valid estimation of state-wide quantities (though study population characteristics were still provided for the readers own comparison). **Weaknesses:** -Sample was skewed to males, ALS, urban setting. -Only swabbed for MRSA in the nares (underestimation). -Small sample size of confirmed MRSA (only 13). -Due to observational nature, could not infer temporality or causality between risk factors and MRSA carriage. -Due to study length, inability to determine if MRSA infections were transient or persistent. -Confidence intervals were wide for many of the results. -Though published in 2016 data was collected in 2009-2010 potentially outdating the results.

Comments:

Studies are beginning to show that current practices for the cleaning and decontamination of ambulances and ambulance equipment may not always be adequate. Inconsistent cleaning and decontamination efforts (in frequency, method, and resources utilized) are leaving behind microbes and potential pathogens in ambulances and on patient equipment, instruments and devices. Furthermore, inadequate hand hygiene, inadequate respiratory (cough) etiquette, ineffective or inappropriate use of PPE, and improper handling of soiled laundry and uniforms are now leaving EMS personnel carrying higher rates of MRSA infection than the general population. Knowledge of and adherence to infection control and it's basic practices appears to be lacking.

Consider: ***Why would you NOT change practice, based on this article?***

Despite its importance few studies have evaluated infection control and the most effective way to approach it in the field of paramedicine. Further research must be done to determine temporality and causality between paramedic knowledge, attitudes and behaviours and resultant contamination of ambulances and equipment and concomitant infection of paramedics and other EMS personnel. Is a lack of knowledge, a lack of adherence, or both to blame? Or are other factors at play? Such as a lack of access to resources while in the field (often uncontrolled, non-sterile environments) or the presence of distracting time pressures. It may not be as simple as re-enforced training on CDC (or equivalent) guidelines as EMS faces unique challenges within the healthcare continuum.

Clinical Bottom Line:

Due to the nature of EMS work, with high call volumes, quick turnover rates, chaotic and highly variable scenes and patients, the spread of contaminated and/or infectious material is common. This poses a serious health risk not only to patients but to paramedics and other EMS personnel as well. Knowledge of infection control basics and adherence to their guidelines is at the foundation of infection prevention and good quality patient care overall. Though these guidelines are not difficult nor complex, these are skills that require consistent use before they will become routine. Education that is standardized and ongoing may help paramedics to practice better infection control, minimizing the spread of infectious material, maintaining their own safety as well as that of their patients.

References:

Orellana, R.C., Hoet, A.E., Bell, C., Kelley, C., Lu, B., Anderson, S.E., & Stevenson, K.B. (2016) Methicillin-resistant Staphylococcus aureus in Ohio EMS providers: a statewide cross-sectional study. *Prehospital Emergency Care*, **20**(2), 184-90. doi: 10.3109/10903127.2015.1076098

Valdez, M.K., Sexton, J.D., Lutz, E.A., & Reynolds, K.A. (2015) Spread of infectious microbes during emergency medical response. *American Journal of Infection Control*, **43**(6), 606-11. doi: 10.1016/j.ajic.2015.02.025

Wepler, M., Stahl, W., von Baum, H., Wildermuth, S., Dirks, B., Georgieff, M., & Hafner, S. (2016) Prevalence of nosocomial pathogens in German ambulances: the SEKURE study. *Emergency Medicine Journal*, **32**(5), 409-11. doi: 10.1136/emermed-2013-202551