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The Journal of Search and Rescue (JSAR) is an open access peer-reviewed electronic journal for the collation and distribution of original scholarly material on search and rescue (SAR).

It is being supported by the in-kind work and contributions of the Editorial Board. There is still the need for a dedicated journal serving those with a direct interest in all disciplines of search and rescue including: rope rescue, water (flat, swift and marine), ice rescue, wilderness search and rescue, structural collapse rescue, trench collapse rescue, cave rescue, dive rescue, motor vehicle extrication, canine search, technical animal rescue, air rescue, search theory, search management, and mines rescue. JSAR exists to fulfil that need.

Article submissions from these and other SAR disciplines are welcome. Launching this journal on the internet offers a relatively cost-effective means of sharing this invaluable content. It affords the prompt publication of articles and the dissemination of information to those with an interest in SAR.

JSAR will provide a forum for the publication of original research, reviews and commentaries which will consolidate and expand the theoretical and professional basis of the area. The Journal is interested in theoretical, strategic, tactical, operational and technical matters.

Advertising within JSAR will be considered in the future to ensure sustainable funding is available to enhance and continue the work of the journal. The publication of an article in the Journal of Search and Rescue does not necessarily imply that JSAR or its Editorial Board accepts or endorses the views or opinions expressed in it.

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Editorial

Welcome to Volume 4, Issue 2: A special COVID-19 issue. Firstly, let me apologise for its lateness. Our intention was to publish very quickly, forgoing the usual peer-review process, in April, following the model established by medical journals such as The Lancet, and New England Journal of Medicine (Rubin et al., 2020). However, a couple of things occurred that meant that that didn't happen; firstly, we received fewer articles than we anticipated, and with hindsight that makes sense – our normal contributors were the people responding to the crisis, and so had limited time on their hands for writing! Secondly, we had a couple of papers that after being sent for initial editorial review, were considered good enough to publish, but very likely to be improved by submitting to the full review process. We then took the decision to review almost all the papers. Where they have not been, they will be marked at the title page to show that.

As I mention above, many of our readers and contributors are very much involved in the response to the pandemic, and in many ways the SAR world continues as normal – we still hear reports of heroism, selflessness, creative adaption to new circumstances and a global commitment to improvement development and functioning so that others may live. Of course, we also hear many of the same less positive reports; the enduring issues around governance , legality, ethics and safety and this month specifically, the misuse of drones.

But that brings me on to the main thrust of this editorial. There are many calls for us to build a better world, as we come out of the pandemic – for environmental protections to be improved globally, for the threat of climate change to be taken seriously and of course for the shameful inequalities and prejudices faced by some of us to end. In short, there are many calls to see this pandemic as an opportunity to heal our societies and our planet, to turn away from violence, prejudice and racism and to end our destruction of the environment.

As scientists, and as those working in the humanitarian sector, I would say we are unlikely to find much to argue with in those global statements – who wouldn't want to live in a more peaceful, fairer and healthier world?

However, that global sentiment can apply with equal resonance to our world. Few of us have been entirely unchanged during the pandemic – emergency calls may or may not have dropped (it probably depends on where you are) but they will very likely have changed in some way. We have seen training via video, socially distanced searches and rescues and rapid changes in policy in response to a complex, unseen and enigmatic disease.

"The new normal" to borrow a phrase from emergency planning, will look different for SAR teams, as it will for everyone else. In the papers in this special issue, we see calls for action in almost every submission – for more research, for changes to the way we work, for recognition of the challenges we face in the work we do. So why not change our SAR world for the better?

Of course, any change does not need to be drastic, limiting or counter-productive. Why not use this new normal, and the enforced break from normality to reconsider our status quo, with small positive steps. This may be in the form of a statement about equality, or re-examining our recruitment. Are we as representative as we could be, or should be? It may be in the form of an environmental assurance, changing the use of fossil fuels or plastics in our work. It may be in the form of a move towards better governance, turning away from the corruption and self-service that still exists in pockets.

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The COVID-19 pandemic is almost certainly not over, despite restrictions in some countries loosening. Inevitably, this means more people will die, or have their lives changed severely in the short or long term. There is a strong possibility that someone reading this will know someone who has contracted the disease, and, devastatingly, some of us will have lost loved ones. COVID-19 has had a deadly toll on all of our populations, let's not waste what positives we may be able to take from the changes it brings.

Dr Ian Greatbatch, FHEA, FRGS, MEPS, FICPEM

London, UK

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Operation Braidwood

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**Letter to the editor. Not peer reviewed.*

Dear Editor,

As the Head of the London Fire Brigade's Technical Rescue, International SAR and Overseas Operations capabilities, I am well drilled in responding to sudden onset disasters and capacity building missions for rising tide events. These challenges have, to date, been met by identified and trained relatively small teams who are well practiced in personal administration, deployment protocol, cultural awareness etc as well as the obvious specific technical skills.

However, how would you or your organisation deal with a request for support to, in effect (given the timeframe) a sudden onset disaster where large numbers of staff without experience, specific skills or cultural (organisational) awareness are required to deploy for an extended period? The outbreak of the Global Coronavirus pandemic presented me with such a challenge and led to the greatest blue light collaboration ever seen between London's three emergency services with 450 volunteers identified, training and deployed into partner organisations within 3 weeks.

What follows is an outline of how this challenge was met. Whilst not directly related to SAR, I'm sure that you can draw parallels with the process, obstacles and achievements which you can either relate to or use for future demands of your own. In March 2020 the London Ambulance Service (LAS), Metropolitan Police Service (MPS) and local authorities asked the London Fire Brigade (LFB) for assistance in response to the unprecedented demand placed upon them.

I was asked to explore ways in which the LFB could support blue light partners and a list of options was drafted for discussion at the Commissioner's Continuity Group (CCG) and then presented at the multi-agency GOLD/Strategic Coordination Group (SCG).

Once agreed, I led the LFB response, named Operation Braidwood, which was delivered by operational staff volunteers across three distinct areas:

- Ambulance Driver Assist (ADA) – Using volunteer Firefighters to co-crew additional ambulances procured in response to the pandemic.

- Pandemic Multi Agency Response Team (PMART) – Multi-Agency teams responding to Covid related deaths in the community to investigate the circumstances of the death, certify the death and prepare the deceased for undertakers.

- Mortuary Body Handling (MBH) – Providing assistance with body handling at temporary mortuaries.

Additional roles were also developed for non-operational volunteers to support their operational colleagues:

- Initial Callers to support the welfare of operational staff in their volunteer roles

- Call Handlers to answer calls at Control to alleviate staff shortages

Ambulance Driver Assist

This involved over 300 operational Firefighters detached to the London Ambulance Service for an initial 3 months to act in the role of driver/assistant. Wembley Stadium was the venue selected to conduct familiarisation training for LFB volunteers. In groups of 40, each 'batch' underwent familiarisation in:

- Ambulance driving
- Ambulance stowage
- Use of equipment
- Casualty handling
- PPE issue

The Firefighters were then allocated to an LAS 'hub' where they observed two full shifts before starting in role. In the first 7 weeks of Op Braidwood, over 25,000 incidents were attended by LFB volunteers. At peak, and extra 168 ambulances were available to Londoners as a result of this arrangement.
Firefighters continue to operate from 22 LAS hubs across London responding to every type of emergency. Feedback from the LFB volunteers and the LAS has been extremely positive, strengthening the relationship between the two agencies. The additional benefit to this arrangement will be the return of over 300 more confident and competent Immediate Emergency Care technicians to the LFB.

Figure 1: Wembley Stadium was the venue selected to conduct familiarisation training for LFB volunteers.

PMART

The Pandemic Multi-Agency Response Team is a Police led initiative to address the surge in Covid related domestic deaths. Each of the 17 teams are formed of 2 police officers (1 Detective), 1 clinician and 1 Firefighter.

Their roles are as follows:

- The Police Detective role is to investigate the circumstances of the death.
- The role of the Clinician is to confirm the death and start the recording process.
- The second police officer and the Firefighter are responsible for wrapping the body in accordance with strict protocol set by the Police.

The teams operated from six police hubs across London. Five of these operated on a 24 hour basis and a central hub that operated during the day. The 96 LFB volunteers undertook an intensive ‘warts and all’ briefing at the LFB HQ which included information regarding each role, PPE protocol and the body wrapping procedure. They were then allocated to a police hub where they underwent further familiarisation with their team.

Figure 2: Crews underwent an intensive training day at LFB Headquarters.

Initial planning prepared to respond to an anticipated peak of 280 incidents per day. Fortunately the figures came nowhere near this total. In the initial 7 weeks that PMART operated, more than 750 bodies were attended to. The capability was official 'stood down' (as opposed to shut down) on Friday 15th May. Teams remain ready to stand up again within 24 hours of a request.

Mortuary Body Handling

A request was received via the Strategic Coordination Group for the LFB to provide another 50 operational staff to assist at temporary mortuaries with body handling. This would include bodies collected from the PMART teams. Initially, a request was submitted for the Military to perform this role, however, that request was never signed off. Various non-government agencies were being used to build the temporary mortuaries and handle the bodies.

At this time the LFB were receiving a lot of enquiries from recently retired LFB staff expressing an interest to help with the cause in some way. The MBH role seemed an ideal opportunity to use those ex LFB officers and fulfil the request for 50 staff. One of the agencies involved with organising this role was *Team Rubicon*. Arrangements were made to sign-post LFB retirees to work for them directly. However, fortunately, the actual need never reached the anticipated fatality levels so this request was withdrawn.

Welfare

The welfare of volunteers is a hugely important element of the project. The support system was divided into 4 levels. A cadre of 60 non-operational staff were recruited to undertake 'buddy checks'. This was a simple phone call after the first couple of shifts to remind volunteers that they were supported. It was then up to each volunteer to agree their bespoke contact programme.

The second level of intervention is the Hub Liaison Officers (HLO). These officers are allocated a cluster of hubs to manage. This provides continuity of both face-to-face and remote support. The HLO's are able to address practical issues such as improvements to the temporary workplace, additional uniform etc. Any issues that they are unable to resolve are escalated to the Silver or Gold officers for resolution. Supporting the 'buddy checks' is a cadre of 10 qualified Mental Health First Aiders (MHFA). These provide the first level of mental health support to volunteers who are dealing with some particularly unpleasant experiences. Providing the third level of support, they make regular contact with each volunteer on a 'candidate led' basis.

Finally, the Brigades Counselling and Wellbeing section which is available 24 hours a day to provide experienced counsellors to support staff. The MHFAs will escalate any complex cases to this group. In cases where staff have reported exposure to particularly unpleasant incidents, this group will make contact immediately without the need for a staged escalation.

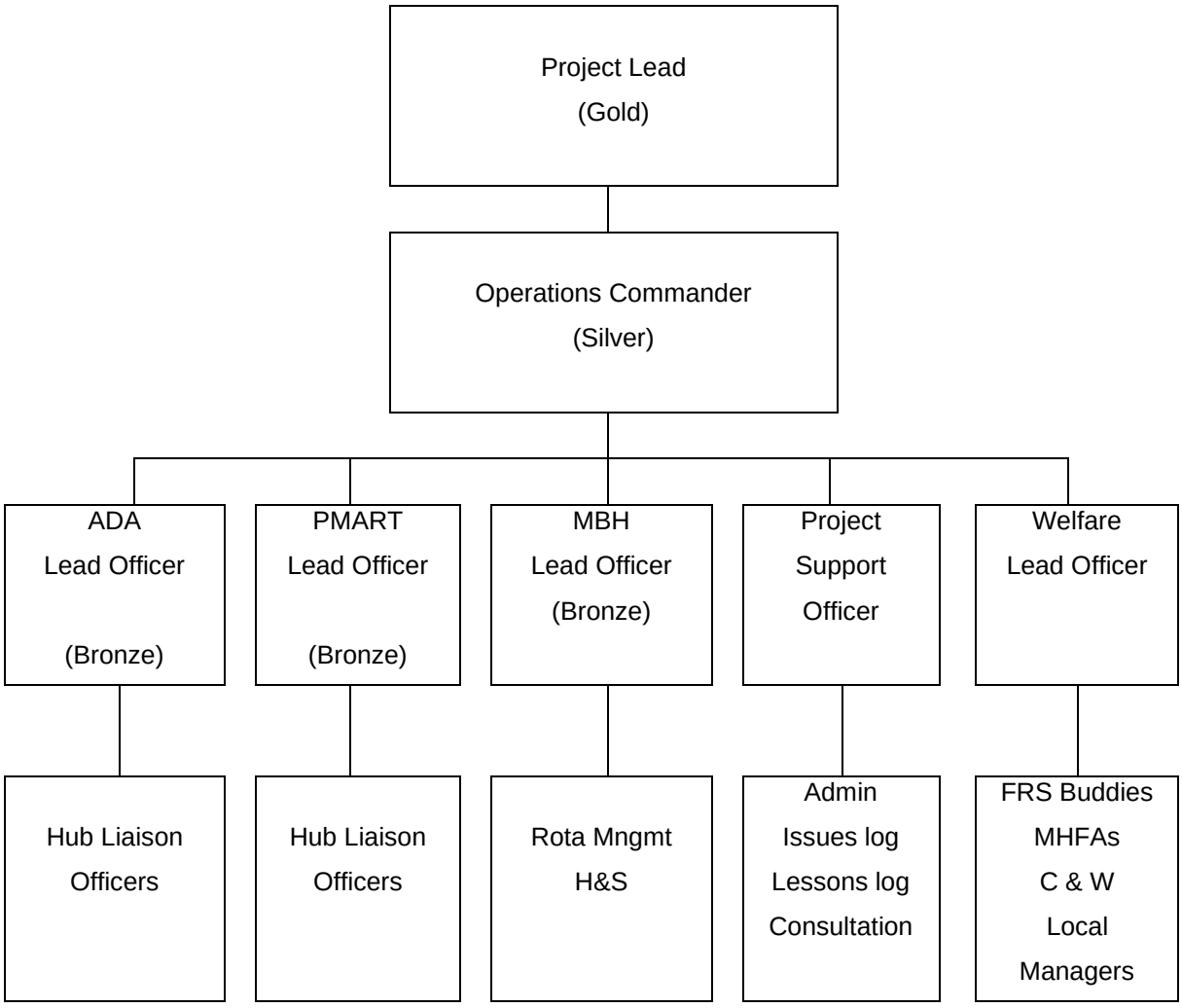

Figure 3: Organisational Structure of the Operation

The Operation Braidwood project team.

Such a complex project working with multiple agencies required a strong project team. A total of 20 officers formed the core project team supported by other elements from within the LFB and across the blue light partnerships totalling some 100+ staff. The urgency of this project required the secondment of staff from various departments within LFB HQ and required unprecedented collaboration between the Brigade and our blue light partners, alongside the NHS, City Hall and local authorities.

The success of Operation Braidwood could not have been secured without the support of staff and Representative Bodies to prepare and secure risk assessments, PPE, training, operational guidance, rota management, facilities issues and welfare. Whilst initially viewed by some as obstacles to success, having robust documentation, clear agreements and comprehensive support laid solid foundations for long term support.

Reflecting on the project, it was apparent that by having clear objectives, defined timelines, regular communication and a committed project team was fundamental to it's success. Whilst it would not be possible or efficient to practice this on such a scale, the blue print for success can now be adapted to suit future large scale demands to meet other crises brought on by terrorism, weather or natural disasters.

P.S. The significant numbers of detachments have only been possible due to unprecedented staff levels due to cancelling of leave, non-critical central and local training.

Abbreviations

ADA	Ambulance Driver Assist
CCG	Commissioner's Continuity Group
HLO	Hub Liaison Officers
LAS	London Ambulance Service
LFB	London Fire Brigade
MBH	Mortuary Body Handling
MHFA	Mental Health First Aiders
MPS	Metropolitan Police Service
PMART	Pandemic Multi Agency Response Team
SAR	Search and Rescue
SCG	GOLD/Strategic Coordination Group

About the Author

David O'Neill is a Principle Officer in the London Fire Brigade (LFB) currently working in the Operational Policy & Assurance department responsible for teams developing operational tactics and policy for Immediate Emergency Care, Technical Rescue, international rescue response, Government liaison, and overseas capacity building projects.

David joined the LFB in 1993 serving at operationally busy fire stations, training department and Headquarters posts. In 2006 David was awarded the coveted Higgins & Langley memorial award for excellence in the field of swiftwater rescue.

After various Station Commander posts, David returned to Brigade Headquarters as a Group Manager responding to major incidents as a National Urban Search & Rescue (USAR) Advisor and National Flood Tactical Advisor.

DAC O'Neill is a deployable expert for the EU Civil Protection Mechanism and NATO and has deployed on response and capacity building missions to countries including Pakistan, India, Tajikistan, Bhutan and most recently Chile.

The Paradigm Shift in Search and Rescue Response During the COVID-19 Pandemic in California

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Abstract

On March 4, a State of Emergency was declared followed on March 19, when the Governor of California issued mandatory stay-at-home orders. Prior to the state mandate on March 16, the San Francisco Bay Area counties issued their own more stringent orders to shelter in place and shut down many businesses. However, the orders exempted essential services including search and rescue. The dilemma…how to provide search and rescue services to the communities we serve and still protect the mostly volunteer search and rescue personnel? This paper discusses how one search and rescue team along with the search and rescue community of the San Francisco Bay area responded to the new paradigm shift, the challenges and changes implemented to respond to a missing person incident, the results of a survey to determine how teams had modified response, and an example of response guidelines during COVID-19.

KEY WORDS: *COVID-19, Shelter in Place, Social Distancing, PPE,*

Introduction

Search and rescue (SAR) services in the state of California are managed by each County with the majority under the Office of the Sheriff. In the San Francisco Bay Area, which include Silicon Valley there are not only volunteer SAR teams in each county, but also specialized resources like dog and mountain rescue teams. The SAR team mostly operates within the county but can be called out for mutual aid (MA) to other counties in California. Additionally, there is an organization called the Bay Area Search and Rescue Council (Young & Cooke, 1995) which was formed to promote and provide a platform for the exchange of ideas, information and training between those organizations providing emergency services to the public in the event of a disaster, catastrophe, or search and rescue within the San Francisco bay area. BASARC was formed in 1990 after a long and protracted missing person search which included resources from every county in the Bay Area including some state and federal resources. The after-action review of that search resulted in the formation of the Council which has been meeting every other month for the past 30 years. In those meetings representatives from each of the nine bay area county SAR teams, local, state and federal parks and State of California specializes

mountain rescue and dog organizations (totally representing about 800 members, come together to discuss training and lessons learned from the previous two months incidents.

The May 2, 2020 meeting was no exception. Within each of the organizations, they were challenged to comply with the restrictions and complicated orders issued to protect the general public and those in emergency services during this COVID-19 pandemic.

This article will site as a baseline, the response to the COVID-19 based on documents prepared by one SAR Team and include additional practices implemented by most of the BASARC teams

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Historic Timeline and Literature Review

The World Health Organization (WHO) first reported a cluster of cases of pneumonia in Wuhan, Hubei Province on December 31, 2019. By the end of January 2020, WHO identified the novel coronavirus as COVID-19 and declared public health emergency outbreak. By mid-March the COVID-19 was declared a pandemic (World Health Organization, 2020). The Centers for Disease Control and Prevention (CDC) prepared and issued guidelines starting in mid-February and has continued to issue new and updated guidelines (Centers for Disease Control and Prevention, 2020).

The State of California Response:

The first confirmed case of COVID-19 occurred in late January. On March 4, Governor Gavin Newsom issued a Proclamation of a State of Emergency then on March 19, he issued an Executive Order of the Governor (N-33-20) (State of Califoria, 2020). To summarize N-33-20 was issued to "preserve the public health and safety, and to ensure the healthcare delivery system is capable of serving all, and prioritizing those at the highest risk and vulnerability, all residents are directed to immediately heed the current State public health directives"…and that "all individuals living in the State of California [are] to stay home or at their place of residence except as needed to maintain continuity of operations of the federal critical infrastructure sectors".

San Francisco Bay Area Counties Response:

Just prior to the Governor issuing Order N-33-20, the Bay Area counties Health Services issued their more specific orders (San Francisco Health Services, 2020). The highlights:

- People shall self-isolate in their places of residence
- All public and private gatherings of any number of people occurring outside a household or living unit are prohibited
- All travel is prohibited
- Exemptions – all first responders, emergency management personnel, emergency

> dispatchers, court personnel, and law enforcement personnel, and others who need to perform essential services are categorically exempt from this Order

Bay Area SAR Team response

Most SAR teams in the Bay Area fall under the Volunteer Services of the Emergency Services Division (ESD) and are currently made up of hundreds of members. The demographics of the teams range from high school aged cadets to those in their 70s and like all volunteer SAR, members are passionate and dedicated to service “so that others may live”. op

The chain of command starts with the volunteer Captain, lieutenants and sergeants who manage the day-to-day activities, training and preparation for searches and other duties as assigned. The volunteer Captain reports to a full-time Sargant who reports up to a Lieutenant and Captain of the ESD. SAR missions are managed using the Incident Command System (ICS), where the incident commander (IC) would be the lead representative from the agency having jurisdiction (AHJ). The rest of the management of the incident would be filling the positions of the deputy IC (the “Search Manager”), Plans, Operations and Logistics Section Chiefs filled by members trained in search management and the Intelligence/Investigations Section Chief filled by both the AHJ and/or SAR members trained in Investigations and Interviewing.

The BASARC teams responded in last few years to sift through the ashes looking for remains in the aftermath of the major fires that spread swiftly in Northern California. Although a daunting task, there were protocols and procedures in place to manage these tasks. However, as the rapid spread of COVID-19 hit the San Francisco Bay area and Orders issued by health and governmental agencies, it became apparent that nobody was prepared for how SAR services would be impacted. There was no time to prepare manuals to deal with a pandemic.

Day to day activities and responding to missing person incident all require SAR personnel working side by side. So, the first order from the sheriff department was that all volunteers need to follow the County Orders and shelter in place so that no volunteer should be placed at risk to contracting the disease. This went along with those who hold full-time jobs and were also directed by their employers to shelter in place. In addition, all schools were closed, which placed an additional burden on parents to stay at home to provide childcare.

Further the departments clarified that until further notice, SAR teams:

- Cannot have in person training or meetings
- Cannot meet in smaller groups
- Would be able to respond to a search for a missing person within County
- Would be able to provide mutual aid for a search outside the county on a case by case basis

At the same time both the County Health Department, and the Sheriff's Office of Emergency Services activated their respective Emergency Operations Centers (EOC). With the activation of EOC's, it was apparent that there weren't enough paid personnel to handle the volume of activities. A decision was made to bring in a limited number of volunteer SAR members to help. Before anyone could enter the EOC they were required to fill out and sign a form with their name, employee/badge number and answer the following questions:

- "Have you been in contact with someone who has been exposed to COVID-19, AKA: Coronavirus in the last 14 days? Yes No
- Have you returned from or been in contact with someone who has travelled internationally in the last 14 days? Yes No
- Have you experienced fever in the last 72 hours? Yes No
- Have you experienced any symptoms such as coughing, difficult breathing, sore throat or general weakness in the last seven days? Yes No

If "Yes" is answered to any of the above questions, you may be sent home. Please advise the front desk and refrain from entering the EOC until screened by staff."

In addition, they must have their temperature taken. If there is indication of a fever, they will be sent home.

Method

Part one – Literature review:

The guidelines published by the CDC were used as the basis to prepare new protocols:

What Law Enforcement Personnel Need to Know about Coronavirus Disease 2019 (COVID-19) (National Center for Immunization and Respiratory Diseases (NCIRD), Division of Viral Disease, 2020)

This included a brief description of the disease, the protocols to protect from exposure including social distancing, washing of hands and recommended personal protective equipment (PPE).

People Who Are at Higher Risk for Severe Illness (National Center for Immunization and Respiratory Diseases (NCIRD), Division of Viral Diseases, 2020)

Those most vulnerable primarily include people 65 and older and those with underlying medical conditions if not well-controlled.

How to Protect Yourself & Others (National Center for Immunization and Respiratory Diseases (NCIRD), Division of Viral Diseases, 2020)

Noted that there is currently no vaccine to prevent COVID-19 therefore the best way to prevent illness is to avoid being exposed to the virus. This includes:

- Washing of hands and the use of hand sanitizers,
- Avoid touching eyes nose and mouth,
- Avoid close contact people who are sick,
- Put distance between yourself and other people outside the home,
- Cover your mouth and nose,
- Cover coughs and sneezes,
- Clean and disinfect frequently touched surfaces

Part two – Questions to consider in preparing for the paradigm shift in protocols for SAR:

All the BASARC teams prepared and executed protocols independently. A set of survey questions was prepared and distributed by the BASARC Chairman Chris Young as part of the agenda for the meeting of May 2.

- How has your team retooled to respond to missing person incidents during the COVID-19 shelter in place orders?
- Explain how teams are managing to continue with online training during SAR-questering.
- How are the teams keeping their members engaged?
- And lastly, what are the plans and changes moving forward after the shelter in place orders are lifted?

This BASARC meeting was conducted online with at least one attendee who could speak for each team. Of the with 30 participants who called into the meeting 7 SAR teams were represented. There were a set of protocols and SAR Mission Safety Guidelines developed by one Bay Area team was used as a baseline for the discussion of each question followed by input from others. (National Center for Immunization and Respiratory Diseases (NCIRD), Division of Viral Disease, 2020) (National Center for Immunization and Respiratory Diseases (NCIRD), Division of Viral Diseases, 2020) (National Center for Immunization and Respiratory Diseases (NCIRD), Division of Viral Diseases, 2020) The collection and analysis of the survey was done by Chris Young during the meeting.

Results

A paradigm shift is defined as important changes that happen when the usual way of thinking about or doing something is swapped by a new and different way (Merriam-Webster, 2020)

All teams agreed that their mission had not changed. We still need to respond to missing person incidents. How we respond had certainly changed.

How has your team retooled to respond to missing person incidents during the COVID-19 shelter in place orders?

Each team started with the basic CDC recommendation for shelter in place (SIP) and social distancing. Those who are at higher risk for severe illness must not respond. The following is one SAR Team Member Mission Safety Guidelines developed internally which covers everything from Callout to Sign-out:

SAR Mission Safety Guidelines (Eichinger, Reserve Capt., 2020)

The below notes are meant to be a guideline for future search missions during the current pandemic. As each mission is unique and dynamic, best practices will be determined by the Search Manager, SAR Liaison, and Agency IC

- **Mission Review** – OES Staff has reviewed the mission and determined that it is an appropriate one for SAR Team including COVID-19 precautions
    - Primary Search Managers and designated team members will carry in their vehicle a Hygiene Kit to serve the initial responding searchers before the [logistics] LOGS Van arrives. This kit will contain hand sanitizer, gloves, Lysol wipes, and a temporal thermometer.

- **Team Member Self-Assessment –** after a team member receives a callout message, they will conduct a self-assessment to determine they are good to participant using this checklist:
    - Is the mission right for me based on the latest CDC Guidelines? Do my loved ones believe it is right for me?
    - Am I in good health? Have I experienced any symptoms such as ongoing cough, sneeze, sore throat, general weakness, congestion, difficulty breathing, in the last 7 days?
    - Have I experience a fever in the last 72 hours? Is my current temperature under 100.4 degrees?
    - Have I been in contact with someone who has been exposed to COVID-19 in the last 14 days?
    - Have I returned from or been in contact with anyone who has travelled internationally in the last 14 days?
    - Have I travelled to a current COVID-19 Hotspot in the last 14 days?

- **"Work from Home" Mission Help**
  - Hasty Squad Members who are confident in MP Flyer Production or Map Production and Segmenting (SARTopo, Avenza Maps®), can asap indicate via SLACK and Hasty Email that they will take the lead in assisting the search mission from their home.

- **OES Mission Vehicle Pick up**
  - Hasty Squad Members who are able to travel to OES to pick up mission vehicles (LOGS Van, [Mountain Rescue Group] MRG or [Urban Search and Rescue] USAR, Porta-potties, etc. are to indicate so asap via SLACK. They are to include their name and eta to ICP.

- **ICP Set Up**
  - **Full Team ICP** - the guidelines to follow are targeted for a Full Team ICP. For Hasty Squad missions, we will use similar guidelines, but scaled back according to the smaller ICP set up.
  - **Safety Officer** – a team member will be assigned as Safety / Health Officer to oversee our Mission Safety Guidelines. In addition to the normal duties during a search mission, the Safety Officer will have these duties;
    - Ensure that a Sanitation Station is set up
    - Ensure that team members wear a face mask / covering
    - Ensure that a Temperature Check and Health Screening Questionnaire are completed for each team member
    - Ensure that proper social distancing is maintained as best as possible through search operations.
    - Assist in ensuring the remaining Mission Safety Guidelines are completed.
  - **Sign-In Table** and Searcher Staging area will maintain social distancing.

- **When you arrive at ICP;**
  - Team members who arrive at ICP and park in the designated parking area, must complete the following 4 items before heading to Sign-in Table;
    - As you leave your vehicle with your gear, ensure that you are **wearing a face mask or face covering**. Do so throughout the search mission. A limited supply of masks may be available to issue as well.
    - Head to the Sanitation Station and **wash and/or sanitize your hands**. Do so again frequently throughout search operations including anytime you return from the field.
    - Complete a **Temporal Temperature Check** - the designated Safety Officer for the search will take your temperature using Temporal Thermometer and record it. A team member with a temperature of 100.4 degrees or more may not participate in the mission.

        - Complete a **Health Questionnaire Form** – the Safety Officer will complete a Health Screening Questionnaire with each team member. Any items marked with a "yes" will confidentially be reviewed by the SAR Liaison.

- **ICP Guidelines**
    - **ICP gathering** - we wish to limit the number of team members within the ICP to avoid gathering / grouping. ICP staff will as best as possible maintain social distancing. Briefings will be made in small team member units and/or over speaker.
    - **ICP areas** - PLOPS, OPS, Plans, Debrief, Download, Radio Issue, Medical, etc. will maintain social distancing both in spacing and limit two team members per function.
    - **Wipe down** - Field Radios will be wiped down before and after issue using a sanitizing sheet. Other commonly touched surfaces through ICP (ex: keyboards) will also be wiped down before and after use. A **micro disinfectant sheet dispenser** will be centrally placed within ICP for team member use.

- **Field Assignments**
    - **Interviews** – our first preference for Intel Interviews with the MP family or RP will be made over the phone or Video Conferencing. If this is not feasible due to the dynamic of the search mission then we wish the interview to be conducted at ICP under controlled conditions. If this is not possible then we would conduct the interview outside the RP residence in open air with proper spacing like a porch, patio, or near-by park bench.
    - **Residence Search** – a search of the interior of the MP residence will be conducted only if it is critical to the mission. Team members entering the residence will be gloved and masked and limited to 2 members using social distancing.
    - **Ground Teams** – ground pounders will use proper social distancing. Ground teams are asked to re-wash their hands before entering ICP for rehab, debrief, and re-assignment.
    - **Driving Assignments** – we wish to have single person driving assignments with frequent check-ins. If available, a second single occupant driver will follow to work a driving assignment together.
    - **Transports** – if a field assignment requires transport, it is preferable that each team member individually self-transport. The 15 Passenger Van can be used, but with a 4-person limit (including the driver) with social distancing.

- **Missing Subject Located**
  - When a missing subject is located the find-team will maintain proper social distancing and notify ICP. Voice commands will be used in effort to determine the subject's [level of consciousness] LOC, [airway, breathing, circulation] ABC, and condition. [Evaluate environment, number of patients, additional resources, mechanism of injury, extrication, spinal] ENAMES.
  - If no urgent or exigent medical condition is found, then the find-team will maintain verbal contact but maintain social distance. The Agency IC will recover the MP.
  - If a medical condition is suspected, then the priority preference would be to allow local Fire Rescue to provide the needed medical care before SAR members go hands-on with proper PPE.

- **Check Out**
  - Team members are asked to wash their hands before leaving for home.
  - Used gloves, masks, micro sheets, etc. will be disposed in a red bio trash bag.
  - Team members to consider changing out of uniform / boots and into different clothing before getting back into auto to head home. "

When considering the selection of the incident command post (ICP) location it is requested of the AHJ that it include restrooms with hot water sinks. Planning to go for a second call out within the team or calling for MA the ICP needs to be large enough to accommodate for social distancing (e.g. schools, places of worship, large public parking lots are ideal for this purpose)

Designated team members (who usually arrive first on scene for search missions) will carry in their vehicle a small sanitation kit containing hand sanitizer, Lysol™ spray, sanitizer wipes, temporal thermometer, gloves, face masks and team paperwork (See Figure 1)

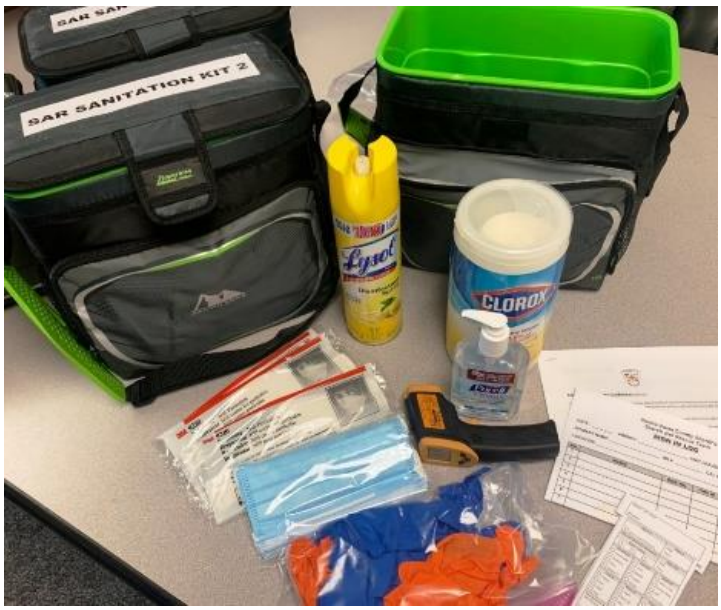

Figure 1: SAR Sanitation Kit (photo courtesy of Contra Costa SAR)

Additional responses during the meeting:

- Most of the BASARC teams follow the same or similar mission safety guidelines. One team required that their members proceed to a muster point which everyone would be evaluated before leaving in a caravan of POVs to the search site.
- One team expressed concerns if the whole team is called out and there's a possible exposure to COVID-19, would the whole team need to be quarantined. A member of the Alameda County (AlCo) SAR, who also works full-time at the AlCo Health Department stated that as long as social distancing and personal protective equipment (PPE) were followed there should be no need for quarantine. He noted that testing in care homes where known COVID-19 has been confirmed, healthcare workers are not required to be quarantined unless symptomatic (National Center for Immunization and Respiratory Diseases (NCIRD), Division of Viral Diseases, 2020).
- It was agreed that if there is a request for mutual aid (MA) SAR teams, then the host agency needs to forward their safety guidelines along with the request.
- Several teams have adopted the National Park Service Risk Calculator App (National Park Service US Dept of Interiors, 2015) based on Operational Risk Management Analysis (ORMA) and "Green Amber Red (GAR) score to evaluate whether it is safe to take an assignment. Team members are encouraged to voice the "right of refusal" of an assignment if there are concerns of exposure
- Many teams used to encourage carpooling to the ICP. This is now discouraged unless the riders are already cohabitants

Explain how teams are managing to continue with online training during SAR- questering.

- All teams have shifted to online trainings using conferencing platforms like Zoom, Webinar or Google Meet either under personal or team accounts. Some are taking advantage of the breakout rooms on the Zoom platform. Subjects include:
    - Frequent focus sessions on navigation, phone apps, GPS, SARTopo, search management, mountain rescue, psychological first aid
    - Helpful tips, training, resources for COVID-19 pandemic.
- Team members are encouraged to send out links via internal emails, social media or group chat platforms about free online SAR related trainings.
- Classes that were underway like Emergency Medical Responder completed the lectures portion. Videos were produced showing the skills demonstration done properly so student can practice on their own. The final written and skills testing will be completed upon lifting of the SIP. It was also noted that the American Red Cross has extended the expiration dates of current certifications until such time as SIP is lifted

How are the teams keeping their members engaged?

- All Teams recognized the need to keep their members engaged during the SIP and it is difficult to maintain comradery and a sense of community. Communication is the key. Some of the methods used:
    - Frequent team updates via Captain's Note Team Email
    - Everyone has been affected differently during the SIP. So some teams have initiated welfare checks – like the old "phone trees" team members calling team members just to say hello and see how they are fairing
    - Team wide puzzles, quizzes, top ten lists, trivia
    - SAR Book Club – weekly Zoom chat on SAR related books
    - Team Wide Food Drive that members can rally behind – one team's efforts resulted in 70 cars stopping by that filled 6 barrels, $2700 in cash, which equalled over 12,000 meals.
    - Team Member Concerts – each Friday night has been live SAR concert with up to 45-50 team members watching online
- Many teams have the monthly or bi-monthly trainings online and have noted that participation is in the high 80% of the full team membership
- Interestingly, all teams are still recruiting with online orientations. Others are completing academies and first-aid trainings as far as they can go online. It is expected that they will complete the in-person training once the SIP is lifted

What are the plans and changes moving forward after the shelter in place orders are lifted?

- For All team their Sheriff's departments have not given SAR any indication or insight to future dates or guidelines about a re-start. They are too busy with the pandemic

- Training staff are making plans for future trainings with groups of 30 and less. Examples:
    - Mock Search – would have an ICP with 30 and less, Division A, B, and C with all less than 30 and still conduct a Mock Search.
    - Also, we are looking to conduct several two hour trainings for groups of 30 or less and have an online sign up for specific time periods. For example, one DSAR training for a Saturday Group 1 (0800-1000), Group 2 (1030-1230) and Group 3 (1300-1500) with 30 in each group we can train up to 90.
- All the SAR teams will continue with online trainings and it will be a slow start for in person trainings with perhaps more outdoor venues for map and compass/GPS or conditioning hikes with other field exercises.

Discussion

Discussion of the responses to the original agenda questions

One of the missions of BASARC is to provide a forum for the exchange of ideas. In the response to the questions it was easy to see that all the teams in the Bay Area had come up with the same solutions with a few variables that may have been unique to their own organization. It is therefore easy to speculate that the majority of those involved in SAR with the same restrictions enforced in their jurisdiction have come up with the same solutions. Those in more rural areas may not need to be as restrictive.

Safety has always been the number one priority in SAR. The COVID-19 pandemic created new obstacles to preserving searcher safety. The implementation of some of the solutions found in the survey have yet to be tested during a real-life missing person incident. Time will tell and it is expected that other unique solutions present themselves to questions no one has thought about at this time

SAR is all about people working together. When we can't get together it's hard to stay enthusiastic and engaged. Communication amongst team members has evolved to embrace solutions often found in the business world. Training has shifted to online solutions using cloud-based conferencing tools like Zoom and GoToMeeting and it is expected this trend will continue long after the SIP orders are lifted. Some of the solutions to keep team members engaged have been very creative, humorous and even educational.

Other discussions from the BASARC meeting of May 2:

At the end of every BASARC meeting there is a discussion of lessons learned from MA and individual SAR team missions since the previous meeting. During this meeting there were six incidents. Most resolved early while ramping up resources. However, there were a few points related to COVID-19:

- One team search for an elderly walkaway had the added complication that his spouse was at home with COVID-19. Fortunately, the missing subject was found before the need to expose team members.
- Some team's express concerns about "optics". Optics is the public's perception that team members on a search mission are not following the County orders and calling to complain to the Sheriff's Department.
- Another team noted that during two missing person incidents, they were surprised to see local fire department and additional LE personnel arrive on scene to assist. Additionally, both fire and LE launched drones. Although we have used fire and LE as ground force multipliers, it was unusual to have close multiple agencies involved in UAV support and the management of the missing person incident. This created a unified command system with LE continuing as the unified command IC.

Additional thoughts on managing a missing person incident

Since the meeting there have been some offline discussions on the management of a missing person incident. One team has decided to limit their initial call out to 20 volunteers. The rationale still follows the safety criteria to limit exposure and still have enough personnel to evaluate the situation and make recommendations on further callout for resources. The assignment distribution will be as follows (Figure 2: Revised assignments and standard required personnel to perform) (Eichinger, Reserve Capt., 2020):

ASSIGNMENT	**PERSONNEL**
Unified command IC (Fire, LE, Drone)	LE
Search manager	1
Plans, Logistic, Operations, (PLOP)	1
Intelligence/investigations - interview team to talk to the reporting parties or family members,	2
Secure the point last seen (vehicle, house, campsite, trail entry)	LE
Full Time Safety COVID-19 officer	1
If it's an urban search assign teams to search the residence,	LE
Start trail searches (linear assignments) or	2-3
Road patrols,	4-1/car in pairs
Started trailing dog	1- handler 1-flankerdog
IT/logs/flyer/computers (in log van one arrives)	1
On scene radio dispatch include Meister	1
Standby member	1
Total	**20**

Figure 2: Revised assignments and standard required personnel to perform

Another search planning tactic currently being used by a few of the teams in the San Francisco Bay area is the virtual search management model. Management personnel are staying home and using search management software like SARTopo to write assignments, mark-up and attached maps all while ground team members are in route. Once on scene team assignments and maps are downloaded to mobile phones using applications like Avenza Map.

Other paradigm shift considerations:

- A Type III search assignment in a straight-line grid – searchers can be no closer together than 6 foot and must be wearing PPE.
- Safety officer – Although the safety officer's function is well defined in ICS (e.g. checking ropes and anchors before allowing personnel to go over the cliff), this new responsibility is not well defined. Policing and enforcing the Mission Safety Guidelines will require training. The safety officer will need to be more vigilant, make sure personnel do not inadvertently bypass check-in, forget to don their PPE or practice social distancing.
- Single driver safety – needs to be extra vigilant to prevent accidents on urban roads. Follow car needs to maintain extra reaction time distance. It was also suggested to mark POVs with magnetic signs or other markings denoting SAR personnel.
- When transporting teams to their assignments using a 16 passenger van the maximum number of people, including the driver, should be 4 in order to maintain social distancing. Considerations may be made to add additional personnel if the length of time in the vehicle is short.
- Virtual search management considerations – although SARTopo can be used off-line, if used virtually it will need some sort connectivity to download assignments and maps to be printed or uploaded to Avenza. Users may need to stop to download before cell coverage drops off.

Limitations

This paper represents one SAR team's look at the paradigm shift in the beginning of the COVID-19 pandemic with additional input from other teams around the San Francisco Bay Area.

Conclusion

The overall mission of SAR is to serve the community and be ready at any time to search for missing persons. One of the key goals has always been safety of our personnel. No one anticipated the changes needed to manage a missing person incident or to maintain the training levels necessary to accomplish the mission. This article represents the paradigm shift of the SAR team of the San Francisco Bay Area to the COVID-19 pandemic and the specific changes that were made along with best practices discussed.

As of this writing the SIP and social distancing orders have not changed. There's no idea when it will be lifted. It is anticipated that it will be a gradual lifting which could take months. It is obvious that nothing will be the same until such time as a vaccine is developed for the COVID-19 which again is anticipated to take months.

Future research and surveys of the best practices will need to be conducted over the next several months. Then at some future point in time perhaps 2 to 3 years a look back will need to be made to determine if the adjustments and best practices were necessary. It is hoped that none of us will have to go through a pandemic such as this that generated so much change in our day-to-day activities.

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About the author

Christopher S Young has been active in Search and Rescue since 1981, managed searches since 1986, is the past reserve Captain for the Contra Costa County Sheriff's Search and Rescue Team and serves as chairman of the Bay Area Search and Rescue Council, Inc. (BASARC). Chris is a retired Instructor for the POST "Direction and Control of the Search Function Course" for the State of California Office of Emergency Service for 25 years, is currently an Instructor Trainer for the "Managing the Lost Person Incident" and "Urban Search Management" (developed by Chris) for the National Association for Search and Rescue (NASAR), he is also an Instructor Trainer in Emergency Medical Response and first aid for the American Red Cross since 1972, as well as specialized topics in Search Management, including Search Management in the Urban Environment, and Investigation and Interviewing in SAR. Chris has also written, published and presented search management papers at the National Association for Search and Rescue conferences, the Canadian National Search and Rescue Secretariat SARSCENE conferences, the William Syrotuck Symposiums on Search Theory and Practice, the Canadian Coast Guard College, the Provincial Sûreté Du Québec Police, the Ontario Provincial Police, the New Zealand National SAR Conference, the Icelandic International Search and Rescue Conference, Norwegian Frivillige Organisasjoners Redningsfaglige Forum (FORF) Seminar and several State Search and Rescue conferences. He is also co-author of the book **"Urban Search – Managing Missing Person Searches in the Urban Environment"**, published 2007 by dbS Publications as well as a contributing author on several other books for search and rescue. Additionally, Chris is a Level 1

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Abbreviations

2019-nCoV	Coronavirus Disease 2019
ABC	Airway, Breathing and Circulation
AHJ	Agency Having Jurisdiction
BASARC	Bay Area Search and Rescue Council
CDC	Centers for Disease Control
COVID-19	Coronavirus Disease 2019
EOC	Emergency Operations Center
ENAMES	Environment, Number of patients, Additional resources, Mechanism of injury, Extrication, Spinal precautions
ESD	Emergency Services Division
GAR	Green Amber Red
IC	Incident Commander
ICP	Incident Command Post
ICS	Incident Command System
LE	Law Enforcement
LOC	Level of Consciousness
LOGS Van	Logistics Van
MA	Mutual Aid
MRG	Mountain Rescue Group
OES	Office of Emergency Services
ORMA	Operational Risk Management
PLOPS	Plans, Logistics, Operations
POV	Personal Owned Vehicle
PPE	Personal Protective Equipment
SAR	Search and Rescue
SARS	Severe Acute Respiratory Syndrome
USAR	Urban Search and Rescue
WHO	World Health Organization's

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Comparing the impact of COVID-19 on Search and Rescue and fire emergency incident responses

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Abstract

The COVID-19 pandemic resulted in stay-at-home orders in many countries. Europe and North America were most affected for during the first wave in March, April, and May 2020. The mobility of the general population was significantly reduced, with governments directing people to remain indoors unless absolutely necessary. However, the impact on Search and Rescue (SAR) and the other emergency services was unclear, as although the teams themselves were not subject to lockdown, many of the factors leading to their deployment had to change significantly.

Data was collected from SAR organizations that had previously contributed to the International Search & Rescue Incident Database, the United States Coast Guard SAR office, and the London Fire Brigade for the months of March, April, and May for both 2020 and 2019. A significant decrease in incidents was seen in 2020 for the Virginia Department of Emergency Management, The Air Force Rescue Coordination Center, and for the London Fire Brigade. All of the other sources had no statistically significant change while some did show minor increases. It appears, with certain data limitations, that SAR organizations should continue to plan for approximately the same level of response even during a pandemic and should prepare appropriate response guidelines.

Key Words: SAR, Fire and Rescue, COVID-19, Incidents, Seasonality

Introduction

The initial cases of COVID-19 were first reported to the World Health Organization (WHO) on December 31, 2019. (H. Lu, 2020). The causative agent, a virus, was named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) and the disease was named COVID-19 by the WHO. (WHO, 2020). On March 11, 2020 COVID-19 was declared a global pandemic by the WHO (Cucinotta, 2020). The US Center for Disease Control (CDC)

estimates the virus was being transmitted in communities by late January to early February and entered the United States in January, with early cases going undetected (Jorden, et al., 2020). From January 21st to February 23rd, 2020, fourteen U.S. cases of COVID-19 were detected, with all fourteen related to travel from China (Jernigan & CDC COVID-19 Response Team, 2020) (Schuchat & CDC COVID-19 Response Team, 2020). The first non-travel related case was confirmed in California on February 26, 2020 (Heinzerling, et al., 2020). On March 13th a national emergency was declared in the US (Jorden, et al., 2020). On March 11th both Washington and California limited gathering (IHME, 2020). By March 23, nine states had issued stay-at-home orders and by April 7, 2020 42 states and Washington, D.C. had stay-at-home orders (Mervosh, et al., 2020). The world-wide impact resulted in travel bans, restrictions on public gatherings, and community mobility (Gossling, et al., 2020).

Access to the outdoors was also affected. Most National Parks were closed or had restricted access (Repanshek, 2020). Police were criticised for their actions on policing UK National parks and scenic locations (Gupta, et al., 2020). State Park facilities were closed or restricted around the US and in Canada, a request to avoid outdoor recreation in order to preserve Search and Rescue resources was made by the British Columbia Search and Rescue Association (BCSARA, 2020).

The purpose of this paper is to investigate any detectable impact COVID-19 had on search and rescue and fire response during the months of March, April, and May 2020. Any change would have an impact on both immediate planning and long-term (strategic) planning given the possibility of further waves of the pandemic (Leung, et al., 2020). The current IHME model for the United States currently shows an increase in COVID-19 starting in mid-August (IHME, 2020). This will impact current and future search and rescue (SAR) response.

Stay at home orders did have an impact on overall mobility. Using March 9, 2020 as the baseline for mobility in the US, a drop started occurring on March 11, 2020 and mobility decreased by 50% by March 30. It fell to its lowest point of 53% on April 6, rose to 41% below baseline on May 1, and continues to rise with 31% below baseline on June 1, 2020 (IHME, 2020). The methodology for calculating mobility changes during the pandemic is described by Gao (Gao, et al., 2020). This work led to the creation of a mapping mobility dashboard by integrating large-scale aggregated smartphone data for daily home dwell time and travel distances which can be viewed online (GeoDS Lab, 2020).

Predicting the impact of a pandemic on SAR response is unprecedented, and literature is sparse. Based upon the decrease in mobility data, SAR incidents might be expected to decrease. However, another possible hypothesis is that an increase in people seeking

outdoor recreation (as outdoor activity is encouraged, considered safe and workplaces remain closed) might lead to an increase in incidents. Within the literature, certain previous trends have been documented with regard to seasonality, and historical records may provide some insights.

Weekly trends in SAR incident response have been previously reported. Kelley (1973) was the first to report basic SAR statistics and found 26% of incidents occurred on Saturday and 30% occurred on Sunday. The ISRID database found 18% of incidents occurred on Saturdays and 15% occurred on Sundays. While the Mountain Rescue of England and Wales reported 19.3% on Saturdays and Sundays. In the Maritime environment the Royal National Lifeboat Institution (RNLI) reported 19% of incidents on Saturdays and 20% on Sundays (Greatbatch, et al., 2019). The London Fire Brigade (LFB) showed a slight increase of incidents on Saturdays but Sundays was the same as the rest of the week (Greatbatch, et al., 2019). Monthly trends were also observed with summer months typically the peak. The peak month for the LFB is July, RNLI is August, and ISRID is July (Greatbatch, et al., 2019). Since a monthly trend exists, it is important to compare each COVID-19 month in 2020 to its pre-COVID-19 month in 2019.

Method

Data was sourced from the agencies either by accessing publicly available datasets (LFB), or by contacting the host agency (Poland GOPR, Winnipeg Police, USCG, AFRCC, Washington Emergency Management Division, Oregon Office of Emergency Management, New Mexico State Police, Virginia Department of Emergency Management), who previously had contributed to the International Search & Rescue Incident Database (ISRID). In addition, data was provided by the USCG for SAR response.

Data Descriptions

The London Fire Brigade data represents all fires and special services for March and April for 2019 and 2020 made available by the London Mayor's office and is freely available to download (London Datastore, 2020). The data shows all incidents attended by London Fire Brigade's equipment, including arson, technical rescue incidents, house fires, car and vehicle extractions, and mutual aid services across the border into neighbouring counties during that period. The data includes date and time, spatial location of the response, as well as attribute data concerning the station, equipment used, and nature of the response,

although this research only used the dates from the records. In total, 15,312 date records were used in this work.

The original ISRID database has been previously described (Koester, 2008). Updates to the ISRID database have also been described (Greatbatch, et al., 2019). Past contributors to ISRID were contacted to determine if they could contribute data in a timely fashion. Data was provided from the Polish Górskie Ochotnicze Pogotowie Ratunkowe (GOPR), which is both a professional and volunteer Mountain Rescue organization. The Canadian Winnipeg Police has a speciality search and rescue team. They reported that they are usually not very busy in the late winter and early spring. Both the United States Coast Guard (USCG) and the Air Force Rescue Coordination Center (AFRCC) are federal providers of SAR response. Therefore, they tend to represent a more complete record of incidents that fall within both their Area of Responsibility (AOR) and area of authority. The USCG has responsibility for maritime SAR and also provides SAR for navigable waters in the US. The AFRCC is responsible for missing aircraft, SARSAT beacons, and provides assistance for missing persons often in the form of cellular forensics. Data from Washington, Oregon, New Mexico, and Virginia all represent state agencies responsible for maintaining records on SAR response in the state. In some of the states, local governments are responsible for SAR and may or may not report the incident to the state.

Data from the USCG SAR office was provided via a spreadsheet. The spreadsheet provided totals for each month, starting and October 2017 and running through June 2020. The data was broken into 45 different categories and then totalled for each month. Only the totals from March – May for 2019 and 2020 were used in the analysis. While the spreadsheet covered a total of 38,706 incidents only 6438 incidents meet the criteria for data inclusion (date ranges).

Contributors were asked for the total number of incident responses during the time of the COVID-19 Pandemic (March-May 2020) and for the corresponding data from the previous year (March – May 2019). Contributors were also asked for any observations regarding their data. Data was provided in either an Excel spreadsheet or via email. Data consisted of the month and year, and the total number of incidents. In some cases the type of incident was provided as well. Data was then combined and placed into a single Excel spreadsheet.

Results

The data was placed into Microsoft Excel for data-organisation and descriptive statistics (Microsoft Corporation, 2018). There was some variation in the datasets, and the various descriptive statistics for each dataset are presented in Table 1. The relevant study period for COVID-19 was March – May 2019 and 2020. While several states and countries have not relaxed stay at home orders or other restrictions, this study was conducted in early June and required a consistent cut-off point. March was chosen as the start point of the study since COVID-19 was declared a Pandemic on March 11th and various states and countries started issuing orders in response. The numbers of cases were collected for March, April, and May of 2020 and data was compared to 2019 in order to make a more direct comparison.

	GOPR (Poland)	Winnipeg SAR	USCG	AFRCC	WA	OR	NM	VA	LFB
n_{2019}	37	2	3161	2557	228	233	39	37	8164
n_{2020}	35	2	3277	2113	211	210	45	15	7148
Change	-5.4%	0.0%	3.7%	-17.4%	-7.5%	-9.9%	15.4%	-59.5%	-12.4%
Mar	-36.4%	0.0%	0.5%	-25.9%	-30.4%	6.8%	20.0%	-72.7%	-7.1%
Apr	-10.0%	0.0%	-7.0%	-17.0%	-14.3%	-36.0%	40.0%	-45.5%	-17.6%
May	18.8%	0.0%	12.7%	-13.2%	18.6%	11.2%	-7.1%	-60.0%	
P	0.814	1.000	0.148	<0.001	0.417	0.269	0.510	0.002	<0.001

Table 1: Shows each data source, the total number of cases for March - May for both 2019 and 2020, the change in percentage between the two years, the change for each month from 2019 to 2020, the P value for the overall change from 2019 to 2020 using Chi-square analysis. See glossary for abbreviations.

It can be seen from Table 1 that the absolute number of incidents increased for the USCG (3.7%) and New Mexico (15.4%) during the period of March – May 2020 compared to incidents in 2019. No change was seen in Winnipeg SAR response (although the sample size was small). A decrease in incidents was seen for the AFRCC (17.4%), Washington (7.5%), Oregon (9.9%), and Virginia (59.5%). The month with the greatest decrease was April. The London Fire Brigade responses decreased by 12.4% during March and April, 2020 with the largest decrease (17.6%) reported in April. At the time of this study, data wasn't available for May. Washington and Oregon reported a large increase in incidents during the

Memorial Day weekend holiday in late May), with Washington showing a decrease in March and April and an increase in May.

Discussion

A significant decrease in incidents only occurred for AFRCC, Virginia Department of Emergency Management, and the London Fire Brigade. This would be an expected result when considering stay at home orders and decreased mobility. While Washington, Oregon, and GOPR experienced an overall decrease, the increase in incidents in May made the overall decrease statistically insignificant. The increase in May was attributed to increased Memorial Day incidents and increased mobility at the end of the month by the State SAR Coordinators (REF or evidence). The USCG and New Mexico experienced an overall increase in incidents, although it didn't achieve statistical significance.

In both 2019 and 2020 a total of 13 weekends occurred. The data was also matched month for month. Therefore, any differences seen were not due to weekends or seasonal trends that have previously been observed. What the data cannot account for is any long-term trends of increasing or decreasing incidents like differences in weather, population, in outdoor recreational participation, at-risk population fluctuations, or in the utilization of state resources. In spite of these unknowns, the COVID-19 stay at home orders remain the best explanation for any changes where they did occur.

Depending upon the location and type of SAR activity, incidents either decreased or stayed the same. This has important planning impacts on SAR organizations. Just because the population is told to stay at home doesn't mean it will. The need for a well-organized SAR response remains. Even in areas that had a statistically significant decrease in incidents, the need to respond still remained.

Limitations

The data was rapidly collected and many previous contributors of data to ISRID and previous studies did not have data available or working remotely made it difficult to provide the requested data. The study period was two simple snapshots in time; three months in 2019 and three months during the COVID-19 Pandemic during 2020. Upward or downward trends could have already been in place as mentioned above and have nothing to do with the COVID-19 changes. Significant decreases could have been erased by a pent-up public heading for the outdoors in late May.

Conclusion

While some statistically significant decreases in SAR incidents did occur for some of the data contributors, most saw either no statistical change or a non-statistical increase. For SAR organizations, the message is clear; it is important to be prepared to respond to SAR incidents even when the public is told to stay at home. This requires significant planning on managing team members who may be infected, at risk team members, representatives from other agencies, and the public. Issues such as transport to scenes of operations, the staffing of command posts and working in the field whilst observing social distancing and decontamination need to be considered. Finally, consideration will also need to be given in cross-border incidents where different legislations and organisations have differing or even contradictory requirements for maintaining biosecurity.

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Abbreviations

AFRCC	Air Force Rescue Coordination Center (US)
AOR	Area of Responsibility
CDC	Center for Disease Control (US)
GOPR	Górskie Ochotnicze Pogotowie Ratunkowe
ISRID	International Search & Rescue Incident Database
LFB	London Fire Brigade
n	Count
NM	New Mexico State Police
OR	Oregon Office of Emergency Management
P	Probability value
RNLI	Royal National Lifeboat Institution
SAR	Search and Rescue
SARS	Severe Acute Respiratory Syndrome
SARSAT	Search and Rescue Satellite Aided Tracking
USCG	United States Coast Guard
VA	Virginia Department of Emergency Management
WA	Washington Emergency Management Division
WHO	World Health Organization

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Decontamination of Technical Rope Rescue Equipment in the COVID-19 Novel Coronavirus pandemic

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Abstract

The SARS-CoV-2 novel human coronavirus, also known globally as COVID-19 and HCoV-19, emerged in late 2019 in Wuhan, China, and is now is causing a global pandemic. At time of writing this pandemic has resulted in 4,170,424 confirmed cases, and, 287,399 deaths (World Health Organisation, 2020b). Despite the risk of contagion, especially from body products as a result of injury, Technical Rescue activities cannot be ceased.

We have incorporated the existing literature on both anti-viral decontamination in general, the known persistence of SARS-CoV-2 on various surfaces and the construction and usage of rescue equipment to consider if effective and safe protocols for the preparation and decontamination of Technical Rescue equipment are available. The importance of continuing Technical Rescue activities, and therefore the importance of determining effective cleaning protocols is discussed, and future work on the impacts of decontamination agents on Technical Rescue equipment is called for.

KEY WORDS: *COVID-19, Technical Rescue, Decontamination*

Introduction

On the 31st of December 2019, Chinese authorities notified the World Health Organisation (WHO) of an outbreak of pneumonia of an unknown aetiology in Wuhan City, in the Hubei Province. In January of 2020 the Chinese had identified a novel Coronavirus, (SARS - CoV2) which was later designated as COVID-19 (coronavirus disease 2019). There is lack of clarity on how the initial outbreak started, although there is some evidence that the source may have initially been a zoonotic transmission at a seafood market in Wuhan city before developing into person to person transmission. (Wu & McGoogan, 2020)

The disease symptoms appear after a median incubation period of 5.1 days and the development of symptoms in the majority of cases appears to be within 11.5 days. (Lauer et al., 2020). The most common symptoms are fever, cough and fatigue although the range of other symptoms is wide and varied.

Information from published studies suggest that transmission of the virus is primarily through respiratory droplets, although there is evidence that symptomatic patients may also have some intestinal symptoms. For the most part, it is believed that person to person transmission occurs through droplet transmission from an infected host (Rothan & Byrareddy, 2020).

There have been a range of governmental responses to the pandemic. Hale et al (2020) describe the Oxford COVID-19 Government Response Tracker (OxCGRT), which uses 11 indicators of response, relating to public gatherings, financial indicators, and COVID-19 testing and contact tracing. Comparing the 149 countries listed in the OxCGRT, across 5 of the indicators (from April 2020) it can be seen that 95% of countries had required schools to close and 75% had required workplaces to close. 95% of countries had cancelled public events, 56% of countries had closed public transport and 87% of countries had put restrictions on internal movement in place.

Wilder-Smith & Freedman describe the practicalities of isolation, quarantine, social distancing and community containment. Ideally for social distancing to be effective it requires a distance of >2m to be maintained between individuals (Blocken et al., 2020) at all times. However, first responders will find that difficult to maintain perfectly throughout the working day, and effectively impossible in the majority of rescue operations.

Although there is some disagreement in the effectiveness, necessity or ethics of public health restrictions (Allcott et al., 2020; Williams et al., 2020), there is a significant school of thought who maintain that these restrictions (or forms of them) will be in place until a vaccine is produced (Leung et al., 2020).

As a result, most branches of emergency services in the developed world face some sort of enforced change, either as a result of precautionary measures, (including the wearing of face coverings, distancing, reduced levels of response) to halt the spread of infection, or as a result of diminished numbers of personnel, making standard operations impossible. One group of emergency responders, falling within both the Ambulance and Fire & Rescue sectors, is that of Technical Rescue.

Technical Rescue can be described as a lifesaving activity using skills, equipment and techniques exceeding those normally used in firefighting or other emergency response (Vines & Hudson, 2004). The term originates with various Fire Services, to differentiate between these activities and mainstream firefighting, but is now in common use across a range of allied sectors, such as Mountain Rescue and Coastguard teams. In particular, it is often described as requiring the rescuer to commit their safety to specialist equipment, during the rescue, and should that equipment fail it could be expected that death

or severe injury would occur. This reliance means that any contaminated equipment must be cleaned, or replaced as rescue activities cannot proceed without it.

Although numerous activities, such as Hazardous Materials response (HAZMAT), Animal Rescue, Urban Search and Rescue or extrication from vehicular accidents could be considered Technical Rescue, for the purposes of this paper we shall limit the scope to rescue from height (see Table 1). To this end, the equipment being considered is rope (referred to typically as “line”), climbing harnesses, work clothing, helmets, rescue harnesses, stretchers and various other hardware components (such as karabiners, pulleys, slings, ascending and descending devices and portable frames for creating height). Cliffs, buildings, span structures (bridges), cranes, sewers, mines and caves are all environments that might require use of Technical Rescue equipment.

Equipment used in Technical Rescue is required to be of a sturdy construction, typically over-engineered to provide a safety margin. This is known as the safety factor of the item and for example, in the United Kingdom, equipment used to support human life in a work environment must on average break at force 10 times greater than the expected load. The commonly accepted figure for a rescue load is 200kg (Vines & Hudson, 2004) so an item must not break at a load lower than (10x200kg) 2000kg, or at a safety factor of 10:1. Despite this high level of redundancy, much of the equipment regularly used in Technical Rescue is even stronger than this.

Some items are designed to be used in a way that reduces their strength. For example, a simple straight piece of rope when tied into a knot may lose up to 50% (Atiyah, 1990; Delaney, 2015) of its strength due to the constrictions on the strand of rope created in the knot. Furthermore, equipment deteriorates from wear and tear. Mechanical friction, internal and external, exposure to chemicals and exposure to sunlight can all reduce the working strength of fibres and, therefore, Technical Rescue equipment (Davis, 2005). Incorrect decontamination could potentially reduce the working strength of the components, and in isolation or in combination with wear and tear, could create a potentially fatal failure.

In the course of treating and rescuing casualties, equipment may come into contact with body products that may expose it to pathogens. Often, the contamination will be visible or witnessed by a team member allowing the equipment to be removed from service and quarantined according to standard procedures. However with SARS Cov-2, equipment may be contaminated in the course of a rescue, training session, routine testing, inventory or any activity where the equipment comes into contact with a person.

Therefore, in order to be of use for emergency response, the equipment should be treated as if it was confirmed as contaminated. The decontamination process needs to be carried out in a way that leaves that equipment completely free of active virus, does not damage or adversely affect the equipment (making it potentially unsafe to use) and leaves the equipment ready to be used immediately, in the event of an emergency response.

Kernmantle rope (the most commonly used climbing and rescue rope, consisting of an outer sheath and inner core) is typically made from nylon and climbing harnesses made from a combination of steel, aluminium alloys, nylon, Dyneema and polyester. Some line is constructed from aromatic polyamide (Aramid) which is similar to Kevlar. These materials provide a high strength to weight ratio, which allows for significant redundancy in the tensile strength of the equipment, but with relatively low weight. Given that much of the equipment needs to be carried to a scene of operations, or worn, the advantages of this are self-evident (Table 2).

In the sampled literature, the manufacturers recommended a luke-warm (<30*) detergent solution for decontaminating harnesses and line, and specifically warned against the use of bleach, stating that this could weaken the nylon in the outer sheath of lines and the fabric components of harnesses, which are considered Technical Rescue equipment here (Beal, 2019, 2018a, 2018b; CAMP, 2019, 2018a, 2018b, 2018c; CMC, 2018a, 2018b, 2018c; Heightec, 2020a, 2020b, 2020c, 2020d, 2017; Petzl, 2019, 2019, 2018, 2014a, 2014b, 2014c; Teufelberger, 2020). Teufelberger (2020) describe experiments conducted on rope which was exposed to a solution of 70% isopropanol and 30% distilled water, and air dried for 48 hours. They report a 2-4% decrease in breaking strength, but a decrease in flexibility. Lawson et al also (2002) also describe a number of methods for decontamination after CBRNe exposure, but focus on decontamination only, and not re-use afterwards.

	Rope	Harness	Helmet	Hardware / connectors	Breathing Apparatus	Respirators	Liquid or Gas-tight suits	Shoring
HAZMAT					✓	✓	✓	
USAR - collapsed buildings or major transport accidents	✓	✓	✓	✓	✓	✓	✓	✓
Rescue from Mud or Ice	✓	✓	✓	✓				
Rescue from Machinery						✓		✓
Rescue from Vehicles						✓		✓
Cliff Rescue	✓	✓	✓	✓				
Animal Rescue (large or small)			✓					
Confined Space Rescue	✓	✓	✓	✓	✓	✓		
Rescue from water - moving and still	✓		✓	✓				
Rope Rescue	✓	✓	✓	✓				

Table 1: Activities potentially considered "Technical Rescue", with typically associated equipment or techniques

Equipment Type	Construction Materials
Metal connectors and other hardware (Karabiners, pulleys, rope grabs)	Stainless steel, high tensile steel, anodised aluminium, bare aluminium, Titanium alloy
Metal wire anchor slings	Stainless steel with swaged eyes and a pvc outer
Textile woven and sewn anchor slings	Nylon (including polyamide), Polyester, Dyneema, Aramid or a mixture of some of these.
Textile woven and sewn harnesses with metal attachment points	
Textile ropes and other cordage/lines	
Stretchers	Plastic and metal for “basket” stretchers Plastic for spine boards / extraction boards Canvas Fabric for USAR / some line rescue stretchers (Cooper, 2018)

Table 2: Construction materials of TR Equipment

Nylon is considered completely unsuitable for exposure to sodium hypochlorite, as it will break down bonds in the polymer and significantly compromise the tensile strength of the harness. Polyester is more resistant to bleach, as a stronger polymer, but is still susceptible to degradation when exposed to sodium hypochlorite at higher temperatures (Campo, 2008).

Beal’s tests on Aramid line suggest that it maintains 98% of its tenacity, (defined as tensile strength (Cordage Institute, 2020)) after 100 hours exposure to a 20% hydrochloric acid solution at 20□C. No information is given regarding bleach specifically, and so it is difficult to predict without proper testing what the impact of exposure to bleach would be. Aramid is also used in ropes with a greater heat resistance, which may be of value when treating any contamination.

Table 3 details the current methods by which organisations respond to a contamination event, from complete disposal of equipment, to various decontamination processes. Most relevant equipment cannot be stored wet, and so must be dried before being stored ready for use; which is all time when it might not be available for use (it can be used while wet, but may not be accessible while drying, or easily stowed for deployment). Table 4 shows a sample of current manufacturers’ advice on decontamination in normal conditions, and where applicable specific advice for the COVID-19 pandemic.

It is clear that Technical Rescue activities cannot cease for the duration of the COVID-19 pandemic, and in many cases, for safety reasons, cannot be substantively changed. Therefore, the only reasonable solution is to continue with rescue activities, but to reduce the risk of infection to or from the rescuer by adopting protection and decontamination procedures, and by following where possible WHO

guidelines (World Health Organization, 2020c). This is to ensure confidence both that the exposure of rescue personnel to infection is reduced, as well as limiting the risk of the rescuers infecting vulnerable people in the process of rescue.

No.	Name	Description	Positives	Negatives
1	Total Disposal	Some teams experience contamination rarely and are comparatively well funded. In cases of gross contamination the equipment is disposed of and replaced.	Simple, low risk of continued contamination	Potentially very expensive
2	Temporary Quarantine	Equipment is quarantined until sufficient time has passed to render any pathogens inactive.	Confidence in decontamination, inexpensive.	Equipment off the run whilst in quarantine.
3	Mild Bleach Wash	Equipment is washed in a mild bleach solution, typically 0.05% sodium hypochlorite in water.	Bleach is readily available, is recognised as a good decontaminant.	Potential for weakening / damaging equipment.
4	Pure Soap Wash	Equipment is washed at max 30°C in pure soap (this is also a standard method for general cleaning) and dried.	Aligned with some manufacturer's recommendations. If done thoroughly, good chance of effective decontamination.	Relies on availability of pure soap.
5	Specialist Cleaner	Equipment is washed in a proprietary cleaner as above eg Beal rope cleaner or Ecolab.	Aligned with some manufacturer's recommendations. If done thoroughly, good chance of effective decontamination.	Relies on availability of specific products.
6	Air Dry	Equipment is washed, air dried and quarantined for sufficient time for any pathogens to become inactive.	Confidence in decontamination, relatively inexpensive.	Relies on availability of specific products. Equipment off the run whilst in quarantine.
7	Hot Water Bath	Equipment is placed in a water bath at 55°C for at least 20 minutes and then allowed to dry naturally.	Demonstrated to be effective against white nose (Throop & Kees, 2016), whilst not initially reducing tensile strength of equipment. Even the lowest breaking strengths for treated lines were well above required minimum breaking strength. There is some risk however that continued washing would weaken lines further.	Exceeds some manufacturer's recommendations.

Table 3: Existing Options for Decontamination, across organisation types

In addition to the direct risk of either infection, or unavailability of equipment due to quarantine or cleaning, logistics systems, staffing and general support functions are severely stressed by lockdowns. This stressing, plus unavailability of staff due to widespread illness, or being seconded to other duties, means that normal replacement services may also be affected. This could be seen to apply to both the equipment itself, or specialist cleaning products (see Table 3).

	Harness		Rope		Helmet		Carabiner		COVID-19 SPECIFIC ADVICE
	Temp	**Products**	**Temp**	**Products**	**Temp**	**Products**	**Temp**	**Products**	
Beal	≤30°C	Delicate Fabric Cleaner Disinfect only using materials that have no effect on the synthetic materials used.	"cold" water	Agent for delicate textiles Disinfect only using materials that have no effect on the synthetic materials used.	"cold" water	appropriate products, which are not harmful to the wearer (soap).	≤20°C	Disinfectant containing quaternary ammonium salts.	NO
Camp	≤30°C	pH Neutral soap.	≤30°C	pH Neutral soap.	≤30°C	pH Neutral soap.	≤30°C	pH Neutral soap.	NO
CMC	"Cold" water.	"Mild Detergent safe for nylon and polyester".	None given	"Mild Detergent safe for nylon and polyester".	Shell: Cold water Padding: =<30°c	Mild soap.	None "clean and dry"	None.	YES
Edelrid		70-100% Isopropanol.		70-100% Isopropanol.		70-100% Isopropanol.		70-100% Isopropanol.	YES
Heightec	Approx. 25°C	Non detergent soap disinfectant compatible with polyamide and polyester.	Lukewarm	For disinfection, only use substances that have no influence on the synthetic materials used.	Approx. 25°C	disinfectant compatible with polyamide and polyester.	Approx. 25°C	disinfectant compatible with polyamide and polyester.	NO
Petzl	≤65°C	Ph neutral soap (household face and body soap).	≤65°C	Ph neutral soap (household face and body soap).	≤65°C	Ph neutral soap (household face and body soap).	≤65°C	Ph neutral soap (household face and body soap).	YES
Singing Rock	≤55°C (Polyamide, polyester or metal, not for HMPE, Dyneema®, Spectra®, Dynex® or similar).	83% of denatured 95% ethanol; 11.3% of distilled water, 4.2% of 3% hydrogen peroxide and 1.5% of glycerol. Maximum 3 times.	Not stated	83% of denatured 95% ethanol; 11.3% of distilled water, 4.2% of 3% hydrogen peroxide and 1.5% of glycerol. Maximum 3 times.	Not stated	83% of denatured 95% ethanol; 11.3% of distilled water, 4.2% of 3% hydrogen peroxide and 1.5% of glycerol. Maximum 3 times.	Not stated	83% of denatured 95% ethanol; 11.3% of distilled water, 4.2% of 3% hydrogen peroxide and 1.5% of glycerol. Maximum 3 times.	YES
Singing Rock	≤30°C	Pure soap (e.g. Lux soap flakes, stergene) at the approximate dilution, with pH range 5.5 and 8.5. Disinfection is necessary, use weak (1%) dilution of Potassium permanganate.	"Lukewarm"	clean water disinfection use weak (1%) dilution of Potassium permanganate.	≤30°C	pH-neutral soap.	≤20°C	disinfectant containing quaternary ammonium salts in warm water one hour.	NO
Teufelberger	N/A	N/A	cold	70% Isopropanol 30% Distilled water.	N/A	N/A	N/A	N/A	YES

Table 4: Manufacturer's instructions for cleaning contaminated rescue equipment, both generic and COVID-19-specific (Highlighted rows).

Literature Review

The COVID-19 novel coronavirus was declared a Public Health Emergency of International Concern (the highest level of infectious disease response categorised by the WHO) on 30 January 2020. At the time of writing less than 4 months have passed since that declaration, which means that much of the information about the virus, its survivability, life cycle, transmission and destruction are still not entirely known. As a result, the literature that does exist is understandably focused on the immediate epidemiology and characteristics of the disease, rather than secondary issues, such as equipment decontamination.

Furthermore, with incomplete data, it is hard to be certain of many of the key factors pertaining to transmission;- incubation period, shedding, R-number and modes of transmission (Cascella et al., 2020; Peeri et al., 2020). However, it would seem to be the case that the SARS-CoV-2 virus is similar in morphology to known coronaviruses in many ways, and as such this (plus what we do know about the novel form) allows us to develop decontamination procedures suitable for rescue equipment (Wu et al, 2020).

To this end, there is both some early work specifically on COVID-19, and generally on viruses (and coronaviruses) and their survivability or persistence on different surfaces and materials, that is relevant to this matter. Kampf et al (2020) conducted a review of 22 existing papers, (Kampf et al., 2020) and concluded that the virus can survive on inanimate surfaces (such as metal or plastic components of rescue equipment) for up to nine days. However, it can be reliably inactivated in around one minute using simple surface disinfectant measures, using ethanol, 0.5% hydrogen peroxide or 0.1% sodium hypochlorite.

van Doremalen et al (2020) compared the surface stability of COVID-91 with SARS-CoV-1 and found that it was similar under the conditions of the test. Specifically, they found that the virus can remain active on plastic, stainless steel, copper, or cardboard for a number days (depending on conditions, such as the inoculum shed) (van Doremalen et al., 2020).

Nogee et al 2020 recommended investigating the widespread use of ultraviolet germicidal irradiation (UVGI) to sterilize clinical PPE such as masks, and this could be effective with rescue equipment, but often requires specialised UVGI rooms, lamps and air conditioning equipment (Varaine et al., 2014).
Throop and Kees (2016) conducted a series of experiments on decontaminating climbing equipment, relating to pathogens such as the fungus that causes white-nose syndrome in bats. Climbing equipment, practically identical to rescue equipment, used by bat researchers and cavers required decontamination after use, and the extent to which that decontamination affects equipment strength was investigated. The equipment was subjected to a hot (55°C) bath, 30 times, and dried naturally each time. Line and harnesses were then tested to industry standard breakage strength tests. The line was calculated to have between 0.2 percent to 2.0 percent less strength than untreated line. The harnesses all passed

the European Standard EN 12277 (Bright, 2014) and the authors could find no evidence that the decontamination had any impact on the integrity of the harnesses.

(Phillips, 2014) for the US national Park service, details cleaning carabiners, harnesses, rope and helmets using warm soapy water, with household soap for harnesses and helmets and ph neutral soap for rope.

Discussion / recommendations

Having established that it is not feasible to cease use of rescue climbing equipment during the pandemic (unlike recreational climbing), it is therefore imperative to establish an effective decontamination protocol. Ultimately, any rescue equipment that is potentially contaminated with the COVID-19 virus must be decontaminated before reuse, but the practicalities of that are not entirely clear from existing literature.

On one hand, the manufacturer's recommendation of lukewarm soapy water will maintain the nylon components of the equipment without question, and should be sufficient to kill the virus (World Health Organization, 2020a, 2014). On the other hand, some agencies are reported to use a weak (<0.05%) sodium hypochlorite solution (which will almost certainly kill a coronavirus), or soapy water at circa 60□C (Throop & Kees, 2016) but potentially puts the wearer in contradiction of manufacturer's recommendations, and so the potential practical decontamination protocols are somewhat limited.

Quarantining equipment for a period beyond the typical persistence of a virus is likely to be effective, but will result in equipment being unavailable for a minimum of 96 hours. Organisations with sufficient quantities of equipment could set up a quarantine rota and replace contaminated equipment with fully quarantined equipment when required. Organisations could consider reducing the number of responding Technical Rescue units, to increase the relative amount of equipment per unit.

According to most available evidence or technical documents. warm soapy water can be used to decontaminate line and harnesses, at a temperature of 30-60°C, using a mild detergent. This would appear to be a sensible and pragmatic approach, although it would be advisable to wear appropriate PPE, during the decontamination. Even mild bleach solutions should be avoided, as a result of the potential catastrophic weakening of polymer-based materials. However, PMI (2014) and McCurley 2009 interpret the NFPA standards as requiring the using of a mild household bleach to decontaminate effected rope, although this is not advocated as a long term solution.

There is a case for further investigation into the use of UV to decontaminate equipment, and in particular, UVGI could potentially be used, with the aid of local medical facilities. However, this

investigation must pay heed to any potential damage to rescue PPE resulting from it's exposure to high concentrations of UV.

This work has identified an urgent case for a dedicated program of research concerning decontamination of rescue equipment, as well as workwear and other PPE, beyond existing work on high-toxicity CBRNe contaminants. In short, the emphasis in the technical and academic literature has been towards weaponised or industrial scale contaminants, and decontamination for viruses or bacteria has, to some extent, been overlooked. A laboratory-based investigation into effective disinfectant measures for rescue equipment, incorporating disinfectant types, concentrations and applications, would be a welcome development. This should incorporate two strands: Firstly, effective removal of contaminants across a viral, bacteriological and blood-borne pathogen spectrum, and secondly, tensile strength and usability of equipment after treatment.

We are aware that this paper offers a limited range of solutions to contaminated rescue equipment, but hope that by bringing what literature does exist together, and indicating further research opportunities, we have contributed to the safe continuation of vital emergency services work across the world, during the COVID-19 crisis and into the future.

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Review of Search and Rescue Response Guidelines to COVID-19.

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Abstract

COVID-19 has impacted how search and rescue (SAR) teams respond to incidents, conduct operations, provide patient care, and demobilize. This review looks at COVID-19 symptoms, transmission, and risk factors that might affect search and rescue response. It then looks at risk assessment that might impact the development of COVID-19 operational guidelines along with several general guidelines that have been developed. A literature search was conducted and six response guidelines from search and rescue organization were located. They represented Maritime, Urban, Helicopter, and Ground Search and Rescue organizations. Elements of each guideline are assessed and important differences between different types of SAR functions explored. All SAR teams should develop guidelines on how to best to respond not only during the COVID-19 pandemic but for future infectious disease incidents as well.

Key Words: Response guidelines, protocols, COVID-19, Search and Rescue

Introduction

On December 31, 2019, twenty-seven cases of pneumonia of unknown etiology were reported to the World Health Organization (WHO) from Wuhan City, China. (H. Lu, 2020). The causative agent, a virus, was identified from throat swab samples and then named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). The disease was named COVID-19 by the WHO. (2020f). On March 11, 2020 COVID-19 was declared a global Pandemic by WHO (Cucinotta, 2020). As of June 8, 2020 the total confirmed worldwide cases exceed 7 million cases and over 400,000 deaths. (Johns Hopkins University & Medicine, 2020). In the United States it has resulted in the deaths of 29 EMS workers (EMS1, 2020), 36 firefighter deaths (FireRescue1, 2020), and 54 law enforcement deaths (PoliceOne.com, 2020). COVID-19 has impacted how search and rescue (SAR) organizations respond to incidents, with several organizations developing response guidelines.

Although, COVID-19 represents a novel coronavirus disease with much unknown, several important papers have started to describe the outbreak. Rothan and Byrareddy (2020) reviewed the symptoms, epidemiology, transmission, pathogenesis, phylogenetic analysis and future directions. Rodriguez-Morales et al (2020) reviewed clinical, laboratory and image features, outcomes, risk factors, and prevalence of comorbidities. Across the 27 articles assessed, 20.3% of patients required intensive care unit (ICU) and of hospitalized patients, 13.9% had a fatal outcome. Yang et al (2020a) looked at seven studies and found the most common symptoms were fever (91.3%), cough (67.7%), fatigue (51.0%), and difficulty breathing (30.4%). The most common co-morbidities were hypertension (21.1%), diabetes (9.7%), cardiovascular disease (8.4%), and respiratory system disease (1.5%). Shereen, Khan, Kazmi, Bashir, and Siddique (2020) looked at the origin and characteristics of human coronaviruses.

Symptoms

The US Center for Disease Control (CDC) originally listed three symptoms of fever, cough, and shortness of breath (Jernigan, 2020). Currently, the CDC (2020i) lists the following symptoms; cough, shortness of breath or difficulty breathing, fever, chills, muscle pain, sore throat, new loss of taste or smell, nausea, vomiting, or diarrhea. Some additional symptoms listed in the literature include sputum production, headache, hemoptysis, lymphopenia, and Chilblain-like lesions on feet and hands, (Ren, et al., 2020; Huang, et al., 2020; Wang, Tang, & Wei, 2020; Carlos, Dela Cruz, Cao, Pasnick, & Jamil, 2020; Landa, Mendieta-Eckert, Fonda-Pascual, & Aguirre, 2020). The symptoms typically appear after an incubation period of 5.2 days (Li, et al., 2020) with a range of 2-14 days (CDC, 2020i). Lauer et al. (2020) similarly reported only 2.5% will show any symptoms after 2.2 days, the median incubation period to be 5.1 days (CI, 4.5 – 5.6 days), and 97.5% will show symptoms within 11.5 days (CI, 8.2 – 15.6 days). However, a unique aspect of COVID-19 is the number of asymptomatic carriers. One report from China had 130 of the 166 COVID-19 infections (78%) detected as being asymptomatic (Day, 2020). A study done onboard the Diamond Princess cruise ship found of the 634 confirmed cases 328 (50.8%) were asymptomatic (Mizumoto, Kagaya, Zarebski, & Chowell, 2020).

Transmission

Knowledge about the transmission of COVID-19 is still limited and being updated. Estimates of the R factor (Reproduction number), which represents the average number of people infected by a person, range from 1.4 to 6.89 with an average of 3.28 from twelve different studies (Liu, Gayle, Wilder-Smith, & Rocklov, 2020). However, this represents an average number. It is possible that many people might infect few people and others might be “superspreaders” that infect many people. This characteristic is accounted for by a value known as “k” (dispersion factor) which describes how much the disease clusters. The lower the k factor the more the disease spreads by fewer people. For the Middle East Respiratory Syndrome (MERS) outbreak k was 0.25, for the Severe Acute Respiratory

Syndrome (SARS) outbreak k was 0.16 and for COVID-19 k appears to be 0.1 (10% of cases cause 80% of the spread) according to Endo et al. (2020) or a median value of 0.54 according to Julien and Christian (2020) using mathematical simulations (Lloyd-Smith, Schreiber, Kopp, et al., 2005). This supports that superspreading plays a major role in the transmission of COVID-19. Many superspreading events have been documented in a COVID-19 database (Leclerc, Fuller, Knight, Funk, & Knight, 2020).

Infections from respiratory droplets of infected individuals are thought to be the predominant human-to-human transmission mode (Peeri, et al., 2020; Huang, et al., 2020). The CDC (2020d) reports that COVID-19 is mainly transmitted through close contact from person-to-person and more specifically: between people who are within 6 feet of each other; through respiratory droplets when an infected person coughs, sneezes, or talks; and when droplets with SARS-CoV-2 land in the mouths or noses of people who are nearby or possibly inhaled. It can also be spread by people who are not showing symptoms. The CDC goes on to report that "it may be possible that person can get COVID-19 by touching a surface or object that has the virus on it and then touching their own mouth, nose, or possibly their eyes." The amount of time the virus is capable of surviving (no virus detected) on plastic is 72 hours, 48 hours on stainless steel, 4 hours on copper, and 24 hours on cardboard. In aerosols the half-life was 1.1 to 1.2 hours (van Doremalen, et al., 2020). Bahl et al. (2020) reviewed 10 studies on horizontal droplet distance and found some evidence supporting aerosol transmission, with eight studies showing droplets travelled farther than 2 meters. In a review paper looking at use of outdoor recreational spaces Freeman and Eykelbosh (2020) acknowledge the potential for aerosol transmission but state the aerosoled virus is not a primary mode of transmission and does not appear at sufficient concentrations to cause an infection. Another study showed that virus samples recovered from air taken from a health care setting were not able to infect cultured cells (Santarpia, et al., 2020). This suggests that transmission is dependent on both close proximity to an infected person and being close for a certain period of time (Ontario Agency for Health Protection Promotion, 2020). The Department of Homeland Security (DHS) reported to the media a test conducted at the National Biodefense Analysis and Countermeasures Center in Maryland that the half-life of the virus on a stainless steel surface was 1.5 minutes at a temperature of 21-24C, humidity of 80%, and simulated sunlight (AFP-JIJI, 2020). In Japan, Nishiura et al (2020) reported that transmission was 18.7 times more likely indoors than outdoors based upon 110 cases. Qian et al. (2020) looked at 1245 confirmed cases of COVID-19 outbreaks where three or more people were involved and found only one outbreak occurred in the outdoors where a 27-year-old male had a conversation with another individual.

Risk Factors

COVID-19, like most diseases, does not treat everyone the same. The overall fatality rate in the US is 1.8%, for those under the age of 20 was zero, for age 65-74 was 2.7%, for age 75-84 was 4.3%, and for those over the age of 85 it was 10.4% (COVID, C., & Team, R, 2020). The CDC (2020g) lists the following risk factors for severe illness from COVID-19: age 65 or older, living in a nursing home or long-term care facility, and anyone with an underlying medical condition if not well-controlled. The medical conditions they list include: chronic lung disease or moderate to severe asthma, heart conditions, severe obesity (body mass index BMI of 40 or higher), diabetes, chronic kidney disease requiring dialysis, liver disease, and people who are immunocompromised. Several different conditions may result in being immunocompromised and the CDC lists: cancer treatment; smoking; bone marrow or organ transplantation; immune deficiencies; poorly controlled HIV or AIDS; and prolonged use of corticosteroids and other immune weakening medications. Williamson (2020) et al lists some additional hospital-based mortality risk factors after looking at 17 million adult patients in the United Kingdom. They used Hazard Risk (HR) as the measure with a score of one being baseline and a number greater than one representing increased risk of mortality. The study found the following Hazard Risk factors: age 80+ (12.6); age 70-80 (4.8); organ transplant (4.7); Diabetes (2.4); BMI >40 (2.3); age 60-<70 (2.1); Male compared to female (2.0); respiratory disease (1.8); recent cancer (1.6); liver disease (1.6); kidney disease (1.7); other immunosuppressive conditions (1.7); chronic heart disease (1.3); and Rheumatoid/Lupus/Psoriasis (1.2). Several other early review papers found similar results and report some additional risk factors such as smoking and hypertension (Vardavas & Nikitara, 2020; Zheng, et al., 2020; Yang J. , et al., 2020).

Objectives for Search and Rescue Response

Even with the COVID-19 pandemic and the resulting restrictions on outdoor activities, the need for first responders, specifically search and rescue services, remains. SAR organizations should have three major new concerns during pandemic response

1. Avoid transmitting or becoming infected by fellow response members and emergent volunteers.
2. Avoid transmitting or becoming infected by search subjects.
3. Avoid transmitting to family members and community.

All three of these objectives are interrelated. An infection transmitted from one team member to another could also result in transmission to family members or to a search subject. A superspreading event among a team could also significantly reduce the organization's ability to respond to incidents. Transmission from a search subject could eventually result in a secondary transmission to other response members and/or family members. It has been stated that search and rescue first responders, both members and organizations, have a higher moral obligation to prevent the transmission of COVID-19 (Boyer, 2020). An additional confounding factor in planning response

guidelines is the fact that many search and rescue responders are volunteers (Lois, 2003; Public Safety Canada, 2013; House of Commons, Transport Committee, 2005). Depending upon the team's organization, compensation for lost time or medical costs may not be available to members if they become infected.

Risk Assessment

In developing response guidelines that may limit operations it is always important to conduct a risk assessment. Well known operational risk assessments within search and rescue include the Green-Amber-Red (GAR) system developed by the USCG (2017). The GAR model has been modified by the National Park Service (NPS) and can be obtained as a downloadable mobile app (NPS, 2014). The Occupational Safety and Health Administration ([OSHA] 2020) prepared a publication called "Guidance on Preparing Workplaces for COVID-19" that starts with performing a risk assessment. It classifies workers at lower exposure risk, medium exposure risk, high, and very high exposure risk and then provides the appropriate guidance. SAR providers classified at very high exposure risk would be conducting aerosol-generating procedures such as intubation, cough induction, or invasive specimen collection on known or suspected COVID-19 patients. SAR providers classified at high exposure risk would be anyone who enters a room with a known or suspected COVID-19 patient, and those transporting a COVID-19 patient in enclosed vehicles, boats, or helicopters. Medium exposure for SAR providers would be those tasks that require frequent and/or close contact (within 2 meters) of those who may be infected with SARS-CoV-2. Here "may be a COVID-19 patient" does not mean known or suspected cases, but instead means a person who has frequent contact with travelers, areas with ongoing community transmission, and high contact with high-population-density work environments. Working in a SAR mobile command vehicle might be an example of medium exposure. Lower exposure is defined as "a job that does not require contact with people known to be, or suspected of being, infected nor with the general public". Clearly in SAR, different roles will face different risks for COVID-19. A remote field task with spacing greater than 2 meters will face less risk than mission base staff working in close quarters. A provider who needs to intubate a subject will face a larger risk. The World Health Organization has also produced a risk assessment tool aimed at health workers (WHO, 2020e). Another important concept in risk management is risk mitigation (USCG, 2017). For example, a team briefing with the entire team present in a small trailer can be mitigated with just the briefer and team leader under an awning outside while wearing a mask. Each task or component of the SAR response should be examined to determine how to lower risk.

General First Responder COVID Guidelines

Several organizations are responsible for providing guidance to first responders and other responders such as the CDC and WHO. They provide an excellent starting place for developing specific team or organization guidelines. The WHO has published several publications that are relevant. These include reports on COVID-19 roles and responsibilities of health workers, infection prevention and control during health care, rational use of personal protective equipment, and advice on the use of masks (2020b; 2020c; 2020d; 2020a).

The CDC has issued several pieces of advice that are relevant to SAR. The Interim Guidance for Emergency Medical Services (EMS Systems) applies to all first responders, including law enforcement, fire services, emergency medical services, and emergency management officials (CDC, 2020e). The guidance covers additional questions for 911 PSAPS, changes in patient assessment, recommended Personal Protective Equipment (PPE), precautions for Aerosol-Generating Procedures, transport of patients, documentation of patient care, cleaning of transport vehicles, follow-up and reporting measures, and EMS employer responsibilities. The guidance also provides an approved list of products that can be use against SARS-CoV-2 (EPA, 2020). The CDC (2020e) has also issued interim infection prevention and control recommendations for patients with suspected or confirmed coronavirus Disease 2019 in healthcare settings. The key points for SAR providers who may provide care to patients during a rescue include: limiting who is on scene, use of masks, use of PPE, patient placement, monitoring and managing healthcare providers, training and educating personnel, and other controls. Since respirators or N95 masks are specified in some circumstances as PPE and a shortage of masks may exist in some areas the CDC (2020a) has also provided guidance on decontamination and reuse of these facepiece respirators. In addition to a shortage of N95 respirators almost all PPE has faced supply shortages. Therefore, the CDC (2020h) issued guidance on strategies to optimize the supply of PPE and Equipment. The guidance addresses how eye protection, isolation gowns, gloves, facemasks, N95 respirators, powered air purifying respirators, elastomeric respirators, and ventilators should be used during conventional, contingency, and crisis capacity with the goal of extending PPE supplies. While the CDC has not issued any guidance specific to search and rescue it does have “FAQs for Wildland Firefighters,” who often set up remote operations similar to a search incident (CDC, 2020b). The CDC (2020c) also has established a web page for first responders that addresses cleaning and disinfection, preventive steps, exposure of critical workers, how to cope with stress, and managing fatigue.

The US federal government has prepared several other guidance documents that are relevant in developing and implementing COVID guidelines. The Technical Resources, Assistance Center, and Information Exchange (TRACIE) developed an EMS infectious disease playbook (ASPR TRACIE, 2017). While developed prior to COVID-19, this document provides guidance for many different infectious diseases that need to be taken into consideration and specifically addresses MERS which was caused by a similar coronavirus. It specifically provides guidance on dispatch actions; standard precautions; precautions for contact, droplets, and aerosols; special respiratory precautions;

precautions for Ebola virus disease/Viral hemorrhagic fevers (EVD/VHF) virus; and other special considerations. This guidance will be just as applicable once the COVID-19 crisis is over. The OSHA document (2020) previously described for risk assessment also provides helpful guidance on procedures for each risk level, workplace related impacts of COVID-19, how to develop an infectious disease response plan/guidelines, and workplace controls.

The American Heart Association (AHA) has issued interim guidelines for Basic and Advance Life Support in response to COVID-19. The AHA provided updated guidelines since previous guidelines did not address the impact of COVID-19. Cardiopulmonary resuscitation (CPR) creates extreme risk to providers since it requires aerosol-generating procedures such as chest compressions, ventilation, and intubation (Edelson, et al., 2020). van Doremalen et al. (2020) has demonstrated these procedures' viral particles remain suspended in the air with a one-hour half-life. The revised guidelines are essentially the same for pediatric and neonatal subjects due to the low risk of COVID-19. For adults the interim guidelines call for PPE, limiting personnel, adding a filter and a tight seal to bag-mask device, cuffed intubation or supraglottic airway and connection to ventilator with filter if possible. In the case of lay rescuer's hands-only CPR is recommended (Edelson, et al., 2020). CPR in the wilderness setting often calls for special guidelines. The Wilderness Medical Society has issued clinical practice guidelines that address CPR in the context of accidental hypothermia, drowning, and avalanche burial (Dow, et al., 2019; Schmidt, et al., 2019; Van Tiburg, et al., 2017). The International Maritime Rescue Federation (IMRF), International Lifesaving Federation's Medical commission (ILS-MC) and the International Drowning Researchers' Alliance (IDRA) have formed a joint working group to develop guidelines on drowning resuscitation in regards to COVID-19 (IMRF, 2020).

It is also important to review state and local guidance in developing response guidelines. These may have a direct impact on what each team may be allowed or restricted from in its response.

Methods

Search strategy

The goal was to locate examples of search and rescue response guidelines that reflect the impact of COVID-19. An initial literature search of Google Scholar, PubMed, OVID, Web of Science, and Google was conducted using the search terms of "Search and Rescue" plus COVID. A filter for only papers written in 2020 was applied. A query was also sent to the US Federal primary agencies for search and rescue as defined by the Emergency Support Function #9 (FEMA, 2016). Examples of international response guidelines would be accepted. A query was also sent to data contributors of the International Search and Rescue Incident Database (ISRID) (Koester, 2008). Papers or documents were selected if they addressed search and rescue response guidelines addressing COVID-19 issues. Papers/guidelines were then compared to determine which topics they addressed and provide examples to other SAR organizations.

Results

The literature search of Google Scholar returned 81 results; PubMed, OVID, and Web of Science zero results; and Google 8,720,000 results. The directed queries produced 4 results. A total of 6 papers/guidelines were found that met the criteria. Two articles were found from the Google Scholar search. Bredmose et al. (2020) describes the process of creating the actual guidelines for aeromedical transport of patients with COVID-19. Young (2020) describes the guidelines developed for a ground or land search and rescue in the Bay Area of California. Found through a general internet search was the "International Maritime Rescue Federation COVID-19: Guidance for SAR Organisations" which addresses maritime and coastal search and rescue (IMRF, 2020). Guidelines for Urban Search and Rescue (USAR) were found on the United Nations INSARG web page (INSARAG, 2020). The United Kingdom Maritime and Coastguard Agency created guidelines with representation from Mountain rescue, land search and rescue, cave rescue, and surf lifesaving organizations (Maritime and Coastguard Agency, 2020). The IMRF and INSARAG guidelines were also provided by the USCG as a result of the query. The Virginia Department of Emergency Management (VDEM) also provided an unpublished copy of its COVID-19 response guidelines developed by ground or land search and rescue teams (COVSAR, 2020).

	IMRF	INSARAG	Bredmose *et al.*	UKSAR	COVSAR	Young
Audience	Maritime	USAR	HEMS	Ground	Ground	Ground
Version Date	April 28	March 18	March 31	May 12	Apr 16	May 22
Dispatch Considerations						
Collect prior COVID intelligence about subject		✓	✓	✓		
Risk assessment	✓	✓	✓	✓		✓
Need to quarantine after deployment		✓				
Individual when not to respond to incident	✓		✓		✓	✓
Self-evaluation (fever + symptoms)	✓				✓	✓
Self-evaluation (previous travel + exposures)	✓				✓	✓
Self-evaluation (personal risk factors)	✓				✓	
Individual Welfare						
Medical check-in (fever + symptoms)		✓				✓
Standard precautions	✓	✓		✓	✓	✓
Different levels for PPE based on risk	✓		✓	✓		
Procedures if PPE limited			✓	✓	✓	
N95 fit tested masks discussed	✓	✓		✓	✓	
Required mask all times						✓
Open air distancing		✓		✓	✓	✓
Use of waterproof clothing as PPE				✓		
PPE vs safety equipment		✓	✓	✓		
Training for donning and doffing PPE	✓		✓			
Training with simulated COVID patient			✓			
Hydration				✓		
If SAR member becomes sick	✓	✓	✓			✓
Response						
Travel in Convoy: Single or smaller number		✓				✓
Compartment Isolation	✓		✓			
Canines: limited contact		✓			✓	
Canines: kenneled during rest and sleep		✓			✓	
Briefings (limiting number)					✓	✓
Briefings (social distancing)					✓	✓
Interviews (tele-conference or distance)						✓
Ground search team tasks (social distance)					✓	✓
Use of Emergent Volunteers					✓	
Procedures for maps, forms, radios				✓	✓	✓

Table 1. Comparison of different guidelines, continued on next page.

	IMRF	INSARAG	Bredmose *et al.*	UKSAR	COVSAR	Young
Facility Management/Base Camp/ICP						
Reduce/eliminate visitors	✓	✓	✓		✓	
Limiting building access to hygiene station	✓	✓	✓			✓
Segregating areas for crews	✓	✓	✓			
Enhanced cleaning of facility	✓	✓	✓			
Limiting training	✓		✓		✓	✓
Avoid sharing food/eating own food		✓	✓		✓	
No eating in sleeping quarters		✓	✓			
Isolation area if member becomes ill	✓	✓				
Subject Medical Care						
Don PPE for all subjects			✓	✓	✓	
Screening patients once contacted	✓				✓	
Wait for EMS alternate transport if possible	✓		✓	✓		✓
Place mask on subject	✓		✓	✓	✓	
Limiting providers giving care	✓		✓	✓	✓	✓
Limiting contact time with subject	✓			✓		
Higher level of PPE if suspected COVID (N95, eye protection, nitrile gloves)	✓	✓	✓	✓	✓	
Stay upwind of subject if possible				✓		
Proper doffing of PPE	✓	✓	✓	✓	✓	
Avoid enclosed or confined space				✓		
Portable isolation units			✓			
Patient packaging	✓		✓			
Resuscitation (CPR)						
Higher level of PPE	✓		✓	✓		
Avoid some respiratory procedures	✓			✓		
Modified BLS and ACLS CPR procedures	✓			✓		
Intubation procedures			✓			
Demobilization						
Reporting of ill responders		✓			✓	
Stress debriefing		✓			✓	
Change out of clothing				✓	✓	✓
Decontamination protocols for clothing	✓		✓	✓	✓	✓
Decontamination protocols for equipment	✓		✓	✓	✓	✓
Disposable of PPE	✓		✓		✓	✓

Guideline	SAR Type	AOR	Version	Location
IMRF	Maritime	Worldwide	April 28	download PDF
INSARAG	USAR	Worldwide	March 18	download PDF
Bredmose et al.	HEMS	Europe	March 31	download PDF
UKSAR	Ground	United Kingdom	May 12	download PDF
COVSAR	Ground	Virginia	May 16	See Appendix 1
Young	Ground	California	May 22	www.jounalofsar.com/issues

Table 2 Reviewed Guidelines source and characteristics. AOR=Area of Responsibility. HEMS=Helicopter EMS

Discussion

Every SAR organization should examine the impact of COVID-19 on their operations and how they will respond through formal guidelines. The six different guidelines reviewed all made some important observations in their introductions. First the guidelines were developed specifically to respond to changes in procedures, protocols, or existing guidelines due to COVID-19. Therefore, some aspects of dispatch considerations, individual welfare, response, facility management, medical care, and demobilization may be addressed in other documents. Since many of the details regarding COVID-19 remain unknown, dozens of new papers come out each day and since guidance from public health is evolving rapidly, the guidelines are subject to change. In fact, the UKSAR guidelines reviewed were the second version dated May 12, 2020 while the first version was dated April 17, 2020. Organizations needed to take into consideration federal and local guidance when developing guidelines. They also had to consider the nature of their particular responders. Some teams are paid responders who operate out of a manned facility while other teams are all volunteers who are responsible for providing all of their own equipment, gear, and even PPE. Finally, each organization had a different area of responsibility (AOR) and different missions which have a tremendous impact. While a ground team may distance themselves two meters apart rather easily, the image of a helicopter crew of pilot, co-pilot, flight nurse, flight paramedic, and patient trying to all stay 2 meters apart inflight creates a humorous but unachievable image. International USAR teams needed to address the impact of 14 days of quarantine upon returning to their host country after an incident. Therefore, when viewing table 1, which lists elements that each guideline addressed or did not address, the reader should not view the individual guideline as being deficient if an element is missing.

The major goal of this review article was to: 1) provide a fact-based foundation for creating COVID-19 response guidelines; and 2) share teams' guidelines, so that everyone can learn from each other and improve their own response capability. Depending upon the circumstances of the SAR organization and the community it serves the greatest threat of transmitting SAR-CoV-2 might be from fellow team members or from caring for patients. The reviewed guidelines demonstrated measures that addressed this issue. Some guidelines called for SAR members to assess themselves for symptoms and/or risk factors prior to response. Some guidelines called for an assessment of fever and symptoms upon arrival at the incident command post. Clearly symptomatic SAR responders should

be screened for COVID and kept from on-scene participation. Unfortunately, a large percentage of cases are asymptomatic or can transmit the disease prior to becoming symptomatic (Mizumoto, Kagaya, Zarebski, & Chowell, 2020; Tindale, et al., 2020). This would suggest that screening for symptoms alone would not suffice to mitigate spread among a SAR team.

Almost all of the reviewed guidelines called for some type of risk assessment. Some types of missions or procedures may not be worth the risk. Someone in command may need to make a go-no go decision. However, most risk management systems call for attempts to mitigate risk factors. This was commonly addressed in the guidelines by different levels of PPE being worn depending upon different risks of transmission of COVID-19. Some of the guidelines provided graphics or tables. The risk to a hasty team searching a wilderness trail on a sunny day is different than a medical provider considering advanced airway management on a known COVID-19 patient.

In developing guidelines, the reviewed example guidelines are an excellent starting place. However, teams will benefit from becoming familiar with the general first responder guidelines developed by the WHO, CDC, OSHA, ASPR TRACIE, and the AHA. Many of the reviewed guidelines give specific links to pages provided by these organizations. This allows the guidelines to be more concise but still makes it easy for readers to seek more in-depth information. It is critical to look at the primary sources frequently to determine if any information has been updated. While the EMS Infectious Disease Playbook was written prior to COVID-19 it does address the SARS-CoV-1 virus which was the cause of SARS (ASPR TRACIE, 2017). It also provides excellent instruction on the proper donning and doffing of PPE. Additional instructions for donning and doffing are given by the European Centre for Disease Prevention and Control and the CDC (ECDC, 2014) (CDC, 2020j). While the current focus is on COVID-19 search and rescue should eventually become familiar with the wide range of infectious diseases. Though many first responders (Fire and EMS) have received training in use of PPE it may be a new topic for many SAR providers. In addition, to the general references listed it is important that teams incorporate local guidelines into team response guidelines as well.

All of the reviewed guidelines addressed individual welfare. A self-evaluation prior to incident response (or reporting to duty) and then a formal medical check-in at the incident seems prudent. Since most of the guidelines performed some type of risk assessment for different tasks, roles, or contact with subjects, this was reflected in different levels of PPE suggested. Half of the reviewed guidelines gave suggestions if suggested PPE was not available. Some of the guidelines mentioned how suggested precautions from primary sources such as disposable gowns would not be practical in a search and rescue environment. One guideline suggested waterproof clothing as an alternative. Other guidelines mention how fire-retardant flight suits, life preservers, and other safety equipment might not be suitable with some of the PPE recommendations.

The area of greatest diversity was on recommendations for masks. Most guidelines recommended putting a mask on subjects, although the INSARAG guidelines (2020) point out, it should be a surgical mask and not a N95 mask, which needs to be fitted and can increase respiratory distress. A majority of the reviewed guidelines addressed N95 respirators, which often remain in limited supply. Paxton et

al. (2020) provides a detailed review of the literature on N95 masks and methods to reuse them. Most of the reviewed guidelines conducted a risk assessment and recommended masks for responders only under specified conditions. The wearing of masks under low risk conditions may have some negative results for response. In the aeromedical context and maritime environments, masks can interfere with communications with the crew, (Bredmose, et al., 2020; IMRF, 2020). This has been backed up by more formal studies on masks' impact on communications, causing headaches, discomfort, and a delay in performing intubation (Burton, et al., 2020). A study on the impact of wearing a respirator-type mask while performing light, moderate, or heavy work found several effects, including an increase in respiratory rate, heart rate, and both systolic and diastolic blood pressure when compared to non-respiratory wear (Jones, 1991). The higher the work load, the greater the impact. (Jones, 1991). Under normal circumstances a surgical mask should be changed after becoming wet or every 4 hours (Lepelletier, et al., 2020). Therefore, some SAR environments may reduce the effectiveness of surgical mask.

All of the reviewed guidelines provided suggestions on how response activities could be modified to reduce exposure risk. These were practical suggestions from single responder in a personally owned vehicle to keeping pilots separate from medical crew. Some of the guidelines addressed the use of canines during the response phase.

SAR responders face a wide assortment of facilities, bases, and incident command posts depending upon several factors. Aeromedical response typically has a fixed hanger facility manned by regular crews. Some ground teams have no fixed facility but simply responders responding to an incident command post. Maritime response is usually directed from a rescue coordination center but the responding resources typically don't have a central base. Therefore, the recommendation for reducing transmission of COVID-19 was different for each SAR provider.

All of the reviewed guidelines addressed how subject medical care would be performed. For some SAR organizations conducting searches it is possible to conduct some amount of investigation while searching or responding to a subject. Therefore, it might be possible to have some understanding of the risk factor of the subject having COVID-19. In some rescue situations this knowledge may be unknown. Several of the guidelines applied a risk assessment to determine if they were the best resource to even provide medical care, other resources may have limited alternatives. While, the AHA has provided revised guidelines for BLS and ACLS resuscitation (CPR), not all of the reviewed guidelines addressed this issue (Edelson, et al., 2020). It might even be required to further modify these recommendations for the wilderness environment.

Demobilization of an incident was addressed by all of the reviewed guidelines, from decontamination protocols to stress debriefing. Two of the guidelines specifically addressed reporting of any ill responders. This is a step that should be addressed in all guidelines, although perhaps it was addressed in other organizational protocol.

Limitations

While this review looked at six different guidelines from four different sectors of search and rescue this doesn't represent the entire spectrum of search and rescue. The various disciplines of SAR include; rope rescue, water (flat, swiftwater and maritime), ice, wilderness (sometimes called ground or land), structural collapse, trench collapse, cave rescue, dive rescue, motor vehicle rescue, technical animal rescue, air rescue and mine rescue (JSAR, 2020). Clearly, not all disciplines of SAR were represented by this review. In addition, some search and rescue teams often do not wish to have guidelines or protocols shared widely because of fear of litigation. Another limitation of this paper was it only looked specifically at COVID-19 guidelines. Many teams may have addressed issues of decontamination, stress relief, PPE, and similar issues in other existing guidelines. Finally information is changing rapidly, so many papers cited were placed on non-peer review severs, and the final papers may change as they go through peer-review.

Conclusion

The goal of this review paper was to help other SAR responder's develop guidelines that address COVID-19 issues. First by providing a fact-based understanding of symptoms, transmission, and risk factors associated with COVID-19. Next, by applying a risk assessment of different roles and the COVID-19 potential of subjects it should be possible to mitigate the risk to rescuers. The best place to start the development of SAR-specific guidelines is from several high quality general COVID-19 guidelines generated by subject matter experts based upon research. Finally, these guidelines must be modified to address the unique factors and working conditions faced by search and rescue providers. Yet, the range of search and rescue is broad, so they must meet the unique needs of each team and environment. It is hoped that the six reviewed guidelines provided will give other SAR teams insight in creating their own guidelines. It goes without saying that knowledge of COVID-19 is changing with new studies and information coming out daily. In, fact many of the papers cited in this review have not finished undergoing peer review and even published papers get retracted. Therefore, authors of guidelines must stay current on new developments.

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About the Author

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Abbreviations

ACLS	Advanced Cardiac Life Support
AHA	American Heart Association
AIDS	Acquired immunodeficiency syndrome
AOR	Area of Responsibility
ASPR	Assistant Secretary for Preparedness and Response
BLS	Basic Life Support
BMI	Body Mass Index
CDC	Center for Disease Control
COVSAR	Commonwealth of Virginia Search and Rescue
CPR	Cardio-Pulmonary Resuscitation
DHS	Department of Homeland Security
EMS	Emergency Medical Service
EPA	Environmental Protection Agency
EVD	Ebola virus disease
GAR	Green-Amber-Red
HEMS	Helicopter Emergency Medical Services
HIV	Human immunodeficiency virus
HR	Hazard Risk
ICP	Incident Command Post
ICU	Intensive Care Unit
IDRA	International Drowning Researchers Alliance
ILS-MC	International Lifesaving Federation - Medical Committee

IMRF	International Maritime Rescue Federation
INSARAG	International Search and Rescue Advisory Group
ISRID	International Search and Rescue Incident Database
k	dispersion factor
MERS	Middle East Respiratory Syndrome
NPS	National Park Service
OSHA	Occupational Safety and Health Administration
PPE	Personal Protection Equipment
R	Reproduction number
SAR	Search and Rescue
SARS	Severe Acute Respiratory Syndrome
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
TRACIE	Technical Resources, Assistance Center, and Information Exchange
UKSAR	United Kingdom Search & Rescue
USAR	Urban Search and Rescue
USCG	United States Coast Guard
VDEM	Virginia Department of Emergency Management
VHF	Viral hemorrhagic fevers
WHO	World Health Organization

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Appendix 1

COVSAR Guidelines

COVSAR
Commonwealth of Virginia Search and Rescue
United……"that others may live"
509 E Beverley Street, Staunton, Virginia, 24401 - 240-355-6640 - VASARCO.ORG

COVSAR COVID-19 Protocols

April 16, 2020

General Information

Given these unprecedented times, the Virginia Department of Emergency Management (VDEM) and the groups that comprise the Commonwealth of Virginia Search and Rescue (COVSAR) Community are following the example of other public service agencies by establishing a COVID-19 Task Force to ensure that all members of the COVSAR Community are protected to the extent possible. The mandate for this task force will be to develop agreed upon personal protection guidelines (Protocols) for operating in the mission environment, including pre- and post-mission protective measures.

The COVSAR COVID-19 Task Force acknowledges utilizing information and protocols shared by external and partner public service agencies and thanks those agencies for sharing their knowledge, expertise and standards. The information contained in this document is intended for COVSAR members only and is not considered the property of COVSAR or VDEM but is the result of shared best practices during a time of national disaster.

These protocols are intended to augment VDEM/COVSAR existing protocols, guidelines procedures and standards and will be effective until 10 June 2020. These guidelines may be extended based on direction and guidance on the status of the COVID-19 virus. Notice of a new expiration date will be provided if the guidelines are extended. Personnel may choose to continue the guidelines on their own even after 10 June 2020. Cessation of these guidelines does not withdraw the need for common sense, common BBP precautions, and eye protection.

Personal Protective Equipment (PPE)

It is understood that PPE is at a shortage nationwide. At this time, the COVID-19 Task Force is attempting to establish a mission deployable cache of PPE. Where certain PPE is indicated in the following protocols, responders should attempt to follow the guidelines and only deviate in the event of a known, imminent, eyes-on, life or death situation. Should a responder initiate action without proper PPE, it will be at the responder's sole discretion and liability.

Safety

These Protocols are meant to protect:

- Ourselves and our families
- Our teammates
- Our Authority Having Jurisdiction (AHJ) partners
- Our subjects
- Emergent volunteers

All responders should use common sense and practice good Body Substance Isolation (BSI) procedures as recommended by the CDC: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html. Every responder should be aware of the COVSAR COVID-19 Protocols and encourage and remind their teammates to implement these safety measures. We are all in this together!

Terminology

Responder: Any COVSAR Member responding to a mission in any capacity.
Subject: Individual(s) whose recovery is the objective of the mission.
Patient: Anyone within the mission environment, including the subject, who is in need of medical or traumatic care including those who may be potentially infected with COVID-19.
Mission Environment: All activities and environments that any and all individuals are involved with, or subjected to, once they have arrived at base and departed base, including signing-in and signing-out.
Safety Officer: Individual who, if warranted, is assigned by and reports to the SMC, and is responsible for the general safety and wellbeing of all individuals in the Mission Environment, as well as ensuring COVID-19 protocols are followed.
Authority Having Jurisdiction: The Chief Executive Officer (or designee) of the agency or jurisdiction that has responsibility for the incident.

Index of Protocols

Protocols

1. Pre-deployment

1.1. Responders who are at a higher risk for severe illness by contracting COVID-19, as outlined by the Center for Disease Control (CDC): https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-at-higher-risk.html, should consider not physically responding to missions. These individuals can still provide critical support functions from home, such as dispatch, remote planning, etc.

1.2. Responders who have traveled overseas or from one of the CDC's nationally recognized COVID-19 "hot spots" or have been exposed to known positive persons, should not respond to any mission until they have been quarantined for 14 days and have followed

these CDC guidelines: https://www.cdc.gov/coronavirus/2019-ncov/travelers/index.html,

1.3. Responders should never respond to a mission if they are not feeling healthy and especially if they meet any of these CDC guidelines for the COVID-19 virus: https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html

1.4. Responders should not deploy if they have signs or symptoms of: fever (100F or greater) or sense of being febrile, cough, shortness of breath, sore throat, flu-like symptoms.

1.5. When possible, Group Dispatchers should inquire about the health and safety of each Responder as a component of collecting availabilities, or at any point before deployment.

1.6. Responders should consider having one or more, fabric-based face covering in their possession should they be needed. Acceptable face coverings include, buff, balaclava, neck gaiter, bandana, etc. Home-made fabric masks may be constructed following these guidelines: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/diy-cloth-face-coverings.html

1.7. Responders should carry several pairs of disposable patient examination gloves (nitrile safety) in the mission environment.

1.8. Eye protection will be required to be worn at all times in the mission environment.

1.9. Reponders should bring additional garbage bags in addition to the minimum required to be worn as an extra barrier should Subject contact be necessary.

1.10. If possible, responders should bring additional PPE and disinfectant materials in their possession, including but not limited to alcohol based hand sanitizers, disinfectant surface wipes, antiseptic wipes, medical (surgical) grade masks, N95 masks, medical gowns, face shields.

1.11. Responders should plan to bring all of their own food and water for the full duration of their time in the mission environment and should try to limit the sharing of liquids and food.

1.12. Responders should have a second set of clothing to change into at the completion of the mission. Soiled/worn clothing should be placed in a sealed bag to be washed upon returning home.

2. Mission Base

2.1. All personnel including COVSAR responders, support personnel, AHJ, etc. should practice 6-foot social distance guidelines as much as possible in the mission environment.

2.2. If warranted, a Safety Officer will be appointed by the SMC at every mission. The Safety Officer will be responsible for ensuring COVID-19 Protocols, in addition to general safety measures, are being followed. The Safety Officer will report directly to the SMC and should be familiar with all CDC and VDEM procedures and guidelines.

2.3. Safety briefings will include the COVSAR COVID-19 Protocols. Current COVSAR COVID-19 Protocols will be posted in the Staging Area, along with other pertinent safety information.

2.4. Optimally, Responders should use their own pen when signing in and out of Base. When signing in, Responders may be asked if they have any of the following signs or symptoms: fever (100F or greater) or sense of being febrile, cough, shortness of breath, sore throat, flu-Like symptoms.
2.5. When possible, Mission Briefings should take place outdoors or in a well ventilated area.
2.6. A separate area in Base should be set up to brief and debrief field teams, well away from the rest of command staff activities and in close proximity to the staging area, but not in the staging area.
2.7. Only the Search Team Leader should approach the briefing/debriefing area, not the whole team. Once briefed, the STL will meet with his or her team and move them away from the staging area to brief the team, who will maintain an appropriate distance from each other.
2.8. Easily accessible trash bags should be placed in both the Command Base and the Staging Area and labeled: For PPE Disposal. The Safety Officer or designee should take control of these bags at the close of the mission and ensure they are disposed of appropriately.
2.9. All K9s and equines should only be managed by their handlers and should be crated or isolated while not actively on task. Petting or interacting with K9s and equines beyond their handler is discouraged.

3. Search Team Tasks

3.1. All Team members should practice 6-foot social distance guidelines at all times while on Task.
3.2. Only the Team Leader should approach the briefing/debriefing area and attend the briefing/debriefing. Not the whole team.
3.3. The Search Team Leader (STL) will be the only team member to handle the Task Assignment Form and will complete the required information for their team, including names, roles, and contact numbers. The team should be issued as many maps as necessary in order to limit sharing of maps.
3.4. Handheld radios should not be shared. If using a radio from a cache, only one person on the team should handle the radio and it should be wiped with a disinfectant after use.
3.5. Each Field Team should be issued, if available, two medical (surgical) grade masks. These masks are only to be used in case of Subject/Patient contact: one mask for the Responder making contact, and one to be used on the Subject. These should be pre-packaged in a sealed ziploc bag. Responder making contact with the Subject may use an N95 mask or higher if properly fitted.
3.6. If the team makes contact with the Subject(s), only one team member - either the Medic or STL - should approach the Subject. If possible, that individual should put on a medical (surgical) grade mask (or one of higher protection), patient examination gloves (nitrile safety) and eye protection before making contact. The Responder making contact should then provide a medical (surgical) grade mask for the Subject, or at a minimum a fabric face covering. The STL/Medic will then assess the status of the

Subject's health, including completion of the Subject Contact COVID-19 questionnaire (See end of document).

3.7. **All subjects must be considered COVID-19 Positive.** The STL should use sound judgement in the use of personnel while conducting a rescue or evacuation evolution and ensure universal precautions are followed.

3.8. All K9s and equines should only be managed by their handlers. Interaction with these animals beyond their handlers is discouraged.

4. Subject Management

4.1. All Subject(s), no matter their Status **must be considered COVID-19 Positive**.

4.2. Only one Responder, either the Medic or Search Team Leader (STL) should approach the Subject. If possible, that individual should put on a medical (surgical) grade mask (or one of higher protection), patient examination gloves (nitrile safety) and eye protection before making contact. That individual will then assess the status of the Subject's health. The Responder making contact should provide a medical (surgical) grade mask for the Subject, or at a minimum a fabric face covering. The STL/Medic will then assess the status of the Subject's health, including completion of the Subject Contact COVID-19 questionnaire (See end of document).

4.3. Subjects should be encouraged, if possible, to walk out on their own or with limited assistance whenever possible.

4.4. Be sure to use proper PPE when managing and evacuating the Subject.

5. Emergent Volunteers

5.1. When at all possible, Emergent Volunteers should not be utilized in the Mission Environment and should be considered a last resource.

5.2. Should the Mission objectives require the utilization of Emergent Volunteers, a separate Staging Area should be established away from all other Base functions including the Responders Staging Area.

5.3. One individual should be put in charge of managing Emergent Volunteers. The Safety Officer, in conjunction with the Search Mission Coordinator and AHJ, will be consulted regarding which tasks and activities Emergent Volunteers may participate in, and determine any screening and safety precautions to be taken before deployment on tasks.

5.4. ALL CDC guidelines for COVID-19 screening should be utilized when screening Emergent Volunteers https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html

6. Demobilization

6.1. The Safety Officer should monitor the sign-out function and ensure all departing Responders are aware of the Personal Post-Mission Decontamination Protocols.

6.2. Any and all shared equipment, including radios, laptops, white boards, etc. should be decontaminated on-site before being packed and transported. All non-disposable equipment used for Subject care and transport should be thoroughly decontaminated.

6.3. Trash bags used for disposable PPE should be collected by the Safety Officer and be disposed of appropriately.
6.4. The Safety Officer should report to the Search Mission Coordinator and the relevant VDEM SAR Coordinator any and all suspicions of COVID-19 exposure in the mission environment.
6.5. K9s and equines should be kept well-groomed to minimize potential spread after exposure to the mission environment. This may include wiping down with cleaning wipes, bathing with a povidone scrub, dish soap or equivalent. Any equipment, including water and food containers, and their travel environment should also be decontaminated.
6.6. Responders should have a second set of clothing to change into at the conclusion of their mission shift. Soiled/worn clothing should be placed in a sealed bag to be washed upon returning home.
6.7. Whenever possible, Responders should decontaminate the inside of their vehicles if the vehicle interior was exposed to other individuals during the mission environment.

7. Personal, Post-Mission Decontamination

7.1. All Responders when returning home should, while using proper PPE, undress and isolate their mission equipment and clothes outside of their home, along with any equipment used. All equipment and clothing should be decontaminated. After decontamination, the Responder should shower before interacting with any individuals.
7.2. Any Responder with any COVID-19 exposure, signs or symptoms that occur any time up to 14 days after their last Mission deployment should immediately report their condition to their Group's Chief Officer. The Group's Chief Officer will inform the VDEM SAR Program Chief of the situation.

8. Post-Mission Physical and Psychological Support

8.1. This pandemic is a life changing event. Psychological stress could be a very real consequence of this event. COVSAR Responder involvement in a Mission has the potential to exacerbate or contribute to other stressors related to the pandemic in their personal life. Please seek assistance from a trained professional if you believe you are experiencing any signs or symptoms.

Subject Contact COVID-19 Questionnaire

1. Does the Subject believe they have COVID-19 (Coronavirus)?
2. Does the Subject know if they currently have an elevated temperature or have had one in the last 14 days?
3. Does the Subject currently have a persistent cough or has had one in the last 14 days?
4. Is the Subject currently having trouble breathing or has experienced trouble breathing in the last 14 days?
5. Has the Subject been exposed to a person known to have had COVID-19 virus in the last 14 days?