JCCRIVITION Winter 2019 Volume 2, Issue 1 CollegeEMS.com

The Journal of Collegiate Emergency Medical Services

Abridged Conference Edition



The Official Peer-Reviewed Journal of the National Collegiate Emergency Medical Services Foundation





Visit CollegeEMS.com for the latest developments and innovations in the collegiate EMS community.

» Crimson EMS revamps mass gathering medical care at Harvard University and treats over 60 patients at multi-day Commencement Ceremony.



- » Illinois Institute of Technology creates on-campus EMS organization with initial focus on community CPR/AED education.
- » Embry Riddle Aeronautical University Emergency Response Team hosts a multi-agency active shooter drill based on Rescue Task Force model.
- » Johns Hopkins Emergency Response Organization (HERO) lays the groundwork for inter-facility transport.



The Journal of COLLEGIATE EMERGENCY MEDICAL SERVICES

TABLE OF CONTENTS

The Official Journal of the National Collegiate Emergency Medical Services Foundation

Abridged Conference Edition

26th Annual Conference of the

National Collegiate Emergency Medical Services Foundation

Editorial

5 Peer Review of Collegiate EMS Scholarly Literature: The JCEMS Approach

> Brittany J. Dingler BA, PA-S & Nicholas M.G. Friedman, BA, EMT

Clinical Review

9 Prehospital Management of Hypoglycemic Emergencies: Evidence-Based Review for Collegiate-Based Emergency Medical Services

> Elizabeth V. Woodburn, BS, NREMT & Paul S. Rostykus, MD, MPH, FAEMS



Case Report

16 Non-Veterinary Emergency Care of Law Enforcement Canines at Mass Gathering Events: A Pilot Training Course for Collegiate-Based EMS Providers

> Caroline Tonozzi, DVM, DACVECC; Maureen McMichael, DVM, DACVECC; Ashley Mitek, DVM; William Weir, MD, FACEP, FAEMS; Michael Smith, MD, FAEMS; Nathan Cornwell



Cover Images

Front Cover: Illinois Fire Service Institute Ambulance *Photo Credit: Illinois Fire Service Institute, University of Illinois*

Back Cover: Pittsburgh Skyline Photo Credit: Sean Pavone ©123RF.com



The Journal of **COLLEGIATE EMERGENCY MEDICAL SERVICES**

Editor-in-Chief Nicholas M.G. Friedman, BA, EMT

Executive Editor Brittany J. Dingler, BA, PA-S

Editorial Board Jose Victor L. Nable, MD, MS, NRP Georgetown University School of Medicine, Washington, DC

Matthew J. Levy, DO, MS, FACEP The Johns Hopkins University School of Medicine, Baltimore, MD

Benjamin J. Lawner, DO, MS, EMT-P, FACEP Temple University School of Medicine, Philadelphia, PA

David Goroff, MS, NRP New Castle County EMS, New Castle, DE

Albert Jagoda, MD Skidmore College, Saratoga Springs, NY

Brent Campbell, BA, AEMT-CC Ambulance Service of Fulton County, Gloversville, NY

Patricia Bosen, MSN, FNP-C Skidmore College, Saratoga Springs, NY

Joseph M. Grover, MD University of North Caroline School of Medicine, Chapel Hill, NC

Lauren N. Gorstein, BA, EMT-B Skidmore College, Saratoga Springs, NY

Michael W. Dailey, MD, FACEP, FAEMS Albany Medical College, Albany, NY

Jeffrey S. Lubin, MD, MPH, FACEP, FAEMS Penn State College of Medicine, Hershey, PA

Publishing & Management Antonio Carl Del Vecchio • Managing Editor

News & Outreach Kiran Syed • News Editor

Reviewers

JCEMS employs a double-blind peer review process for Original Research, Case Reports, and Reviews. The clinical and scientific quality of this publication relies on the rigorous and diligent reviews provided by independent reviewers with subject-matter expertise. JCEMS is grateful for all anonymous independent reviewers who dedicated their time and expertise to contribute to the collegiate EMS community.

General Information

The Journal of Collegiate Emergency Medical Services (JCEMS) [ISSN 2576-3687] is the official scholarly, peer-reviewed journal of the National Collegiate Emergency Medical Services Foundation. JCEMS is published by the National Collegiate Emergency Medical Services Foundation.

Annual Subscription: Visit https://www.collegeems.com for information on purchasing institutional and personal annual subscriptions.

Reprints: Visit https://www.collegeems.com for information on purchasing reprints and single issues.

Correspondence (Editorial): Address mail to The Journal of Collegiate Emergency Medical Services, 117 N 15th St., Philadelphia, PA 19102. Email: JCEMS@CollegeEMS.com

Correspondence (Business): Address mail to The Journal of Collegiate Emergency Medical Services, 117 N 15th St., Philadelphia, PA 19102. Email: JCEMS@CollegeEMS.com

Correspondence (NCEMSF): Address mail to National Collegiate Emergency Medical Services Foundation, PO Box 93,West Sand Lake, NY 12196. Email: info@ncemsf.org

Copyright: The Journal of Collegiate Emergency Medical Services is an open access publication. Individual authors retain copyright over their own articles. Articles are distributed under the terms of the Creative Commons Attribution 4.0 International (CC BY 4.0) License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. The full license is available at: https://creativecommons.org/licenses/by/4.0/. All other content in the journal is copyrighted by the National Collegiate Emergency Medical Services Foundation. All rights reserved.

Online availability: All articles published in print issues of JCEMS are available open access at https://www.collegeems.com. Additional content – not available in print issues – is also published on-line.

Disclaimers: The statements and opinions in articles or other content contained in JCEMS are solely those of the individual authors, contributors, advertisers, and sponsors, and do not represent those of JCEMS, the National Collegiate Emergency Medical Services Foundation, or any representatives, agents, or licensors. The appearance of advertisements does not represent a warranty, endorsement, or approval of the products or services advertised. JCEMS, the National Collegiate Emergency Medical Services Foundation, or any representatives, agents, or licensors make no warranties, representations, or other claims as to the accuracy or completeness of any articles or other content contained in JCEMS. JCEMS and NCEMSF disclaim responsibility for any injury to persons or property resulting from ideas, products, or other content referred to in articles or other content in JCEMS. EMS providers should always consult medical direction and local EMS protocols.

Instructions for Authors: Instructions for authors may be found in the JCEMS Guide for Authors at https://www.collegeems.com. Authors are required to abide by the latest guidelines available on-line at the time of submission.

Peer Review of Collegiate EMS Scholarly Literature: The JCEMS Approach

Brittany J. Dingler, BA, PA-S & Nicholas M.G. Friedman, BA, EMT

JCEMS employs a double-blind peer review process to filter manuscripts for publication. We believe that the process minimizes bias, promotes fairness, encourages appropriate criticism, and strengthens the quality of submitted manuscripts.

edicated to the production of quality scholarship in collegiate- or campus-based emergency medical services (CBEMS), JCEMS strives to uphold the most rigorous standards for peer review. "Peer review" is a commonly-used term in academic medicine, but there is often confusion regarding what peer review is and why or how it is conducted. In this editorial, we will (1) introduce peer review and articulate its importance, (2) describe the unique JCEMS peer review process, and (3) discuss how JCEMS seeks to confront the challenges and limitations associated with peer review.

Introduction to Peer Review

In the context of scholarly literature, peer review refers to the pre-publication review of submitted manuscripts by independent subject-matter experts (ie, the "peers").^{1,2} When peer review is conducted properly, reviewers are well-versed in the research methods described and have a thorough knowledge of the existing body of literature relevant to the topic. Reviewers rigorously examine a manuscript for its quality, accuracy, scope, methodological rigor, depth of research, originality/novelty, and style/organization. Reviewers provide journal editors with their opinions regarding whether or not a manuscript should be published. Reviewers may also provide recommendations for authors to improve a manuscript prior to publication.

Peer review therefore serves two broad functions.² First, peer review aids journal editors in determining which manuscripts are acceptable to publish.^{1,2} Manuscript topics and research methods can be wide ranging – even for a journal focused on a narrow field – and it would be unreasonable to expect editors to have sufficiently broad expertise to critically evaluate all aspects of every submitted manuscript. The input of carefully selected subject-matter experts is therefore necessary for editors to make informed decisions. In effect, the peer review process serves as a filter to select manuscripts that are high quality, interesting, and relevant ie, peer review serves as a quality control mechanism.¹ Second, peer review serves to strength-

Brittany J. Dingler, BA, PA-S is the Executive Editor of JCEMS and a student in the Physician Assistant program at Drexel University.

Nicholas M.G. Friedman, BA, EMT is the Editor-in-Chief of JCEMS and the former Director of Skidmore College EMS.

Key Points

Peer review refers to the pre-publication review of submitted manuscripts by subject-matter experts.

The review process serves as a filter for publication and strengthens the quality of submitted content.

JCEMS employs a double-blind peer review process, in which neither author(s) nor reviewers are made aware of the identify of each other.

Given the limitations and challenges of peer review, readers should always critically evaluate published articles for quality, accuracy, and reliability.

en the quality of submitted manuscripts.^{1,2} Authors are often given the opportunity to revise their manuscript – based on feedback from reviewers – resulting in a published product that is superior to the initial submission. For these reasons, peer review remains the standard for journals that publish scientific research and other scholarly articles, and readers often consider the peer-reviewed status of a journal to be a marker of credibility.¹

Peer review is particularly important for research and scholarship in the CBEMS community. As we discussed in the inaugural issue of JCEMS, there is a scarcity of scholarly literature that is focused on CBEMS.³ As a result, the few published articles on CBEMS are frequently cited in the literature and discussed in practice. Each submitted manuscript must therefore be critically evaluated to ensure its accuracy and reliability. Moreover, CBEMS research may be conducted by early-stage scholars without substantial experience in EMS research and scholarly writing. Coupled with the JCEMS Research Mentorship Program,⁴ peer review serves as a tool to provide developing EMS scholars with guidance in producing quality scholarship.

JCEMS Peer Review Process

There is a wide diversity of peer review processes amongst scholarly

February 2019 · Issue 1 · Volume 2 · JCEMS

journals,¹ and JCEMS is proud to offer a transparent description of its own process. For all manuscripts classified as Original Research, Case Reports, and Reviews, JCEMS employs what is known as double-blind peer review.[†] In brief, each submitted manuscript is reviewed by at least two independent reviewers. To promote unbiased and appropriately critical reviews, neither author(s) nor reviewers are made aware of the identify of each other – hence the name "double-blind." Additional details on the process follow and are described in the schematic (Figure 1).

Initial Review

Manuscripts are initially reviewed by editorial staff for relevance to the collegiate EMS community and suitability for JCEMS. Manuscripts may be declined at this stage without further review.

Identification of Reviewers

Each manuscript that fits the scope of JCEMS is assigned to at least two reviewers - subject-matter experts who do not serve on the JCEMS Editorial Board or staff. Reviewers are identified based on established records of expertise in the given manuscript topic, as often - but not exclusively - evidenced by relevant publications, presentations, advanced academic degrees, and prior experience as an editor or reviewer. All manuscripts with a clinical focus are reviewed by physicians and/or advanced practice providers. In addition, all original research manuscripts are reviewed by established investigators well-versed in the research methodology employed. For all manuscripts that present quantitative findings, a focused statistical review is performed by at least one reviewer with expertise in data analysis. JCEMS will occasionally invite undergraduate students or recent graduates to review manuscripts in select cases where the individual has relevant expertise (eg, a CBEMS leader who spearheaded a CPR training program might be invited to review a manuscript on campus CPR outreach). In practice, it is not uncommon for a JCEMS manuscript to be reviewed by three or four reviewers, particularly if a manuscript spans diverse subfields.

De-identification of Manuscripts

Before a manuscript is sent to reviewers, the editorial staff ensures that the author(s) have removed all identifying details from the manuscript; any remaining details that might enable one to reasonably infer the identity of the author(s) or their institution(s)/organization(s) are removed. The anonymity of author(s) is crucial to maintaining objectivity during peer review – reviewers are expected to base their evaluations solely on the quality of the manuscript and research, not on author(s)' reputation, academic status, gender, race, country of origin, etc.

Manuscript Review

Reviewers evaluate manuscripts for their quality, accuracy, scope, methodological rigor, depth of research, originality/novelty, style/ organization, and practical implications for the collegiate EMS community. Reviewers recommend to the JCEMS Editors that manuscripts be rejected, accepted pending major revisions, accepted pending minor revisions, or accepted without revision. If a reviewer believes that revisions are necessary, the reviewer is expected to provide recommendations for how the author(s) can improve their manuscript. The JCEMS Editors (ie, Editor-in-Chief and Executive Editor) and/or Editorial Board members will also conduct their own review with particular consideration for A) whether the research and writing were conducted in accordance with ethical guidelines (eg, was Institutional Review Board approval obtained if necessary) and B) whether any disclosed conflicts of interest may pose a threat to the validity of the manuscript.

Initial Decision

The Editors carefully consider the comments and recommendations of the reviewers. In cases where reviewers' recommendations conflict with each other – or in cases where aspects of the manuscript are not sufficiently evaluated – the Editors may request additional reviews. Once sufficient reviews are obtained, the Editors make an initial decision regarding publication, and authors are promptly notified. It is exceedingly rare for manuscripts to be initially accepted without requests for revisions.

Revision, Resubmission, and Continued Review

Authors typically have the opportunity to revise and resubmit their manuscripts. Minor revisions might include the incorporation of additional details, corrections of misstatements, or minor alterations in the writing, organization, and style. Major revisions might include the need for additional data, the reinterpretation of findings, significant additions from the literature, or major restructuring of the organization. After revising their manuscript, author(s) may re-submit their work with accompanying replies to reviewers' comments. The Editors evaluate the revisions and may send the manuscript back to the original reviewers, or additional reviewers, particularly if major revisions were incorporated. It is not uncommon for multiple rounds of revisions to be requested. The revision, resubmission, and continued review process will continue until a final decision is made.

Final Decision

The final decision to accept or reject a given manuscript is at the discretion of the Editor-in-Chief. Manuscripts that are accepted undergo copy-editing and the final edited manuscript is approved by the author(s) prior to publication.

S

JCEMS acknowledges that many authors may lack experience submitting to a peer-reviewed journal. New authors should be aware that their manuscript may not be accepted and that multiple sets of revisions may be requested. While the process is challenging, JCEMS is proud to offer authors a high degree of individualized attention – a rarity amongst scholarly journals. JCEMS provides authors with extensive guidance throughout the process, including opportunities to discuss new ideas for manuscripts, informal reviews

⁺ JCEMS readers should note that not all content published in JCEMS has undergone peer review. News pieces and *Editorials*, as well as articles classified as *Perspectives and Opinions* or *Advice and Practice*, may be reviewed solely by Editors and Editorial Board members. Articles in these categories are designed to present commentary or the personal opinions of author(s), rather than scientific research or clinical recommendations. In practice, a manuscript in one of these categories would undergo double-blind peer review in the event that it provides clinical information, a description of a novel program, or in-depth reference to the literature.



Figure 1. Schematic map of the JCEMS peer review process. Details omitted for clarity and described in the text.

of rough drafts, detailed recommendations to improve content, and advice on replying to reviewers' comments. The level of attention that we offer authors reflects our commitment to the education of new researchers and the development of a scholarly culture within the CBEMS community.

Challenges and Limitations

Peer review is rightly regarded as a critical component of academic publishing, but its challenges and limitations must be acknowledged. First, peer review relies on the contributions of experts, who are almost always uncompensated.¹ Identifying suitable experts can be challenging, particularly if a manuscript discusses a novel concept or method, or focuses on a niche topic. Suitable reviewers may not be readily available or have sufficient time to complete an in-depth review.¹ In addition, without financial compensation or public recognition, there are concerns that reviewers may not be motivated to conduct a thorough review.⁵

Additional challenges exist surrounding the possibility of bias in the review process.^{1,6} Even in double-blind peer review, reviewers may be able to infer the identity of the author(s) or their institution(s) based on the subject matter, writing style, citations, or other details – for small fields, the concern is especially relevant.⁶ If author(s) or their institution(s) are identified, reviewers may bias their evaluation – positively or negatively – based on characteristics unrelated to the quality of the manuscript (eg, prestige of the author(s)' academic institution or the author(s)' gender).⁷ Bias may also enter the process without identification of the author(s) or their institution(s). For example, a reviewer's evaluation may be consciously or unconsciously biased by a financial conflict of interest, a personal belief that conflicts with statements expressed by the author(s), or a desire to advance their own research careers at the expense of the author(s). Beyond bias, cases of outright peer review fraud have also been uncovered in which authors have created fake email accounts to review their own manuscripts.⁸

Novel forms of peer review have been developed in an effort to overcome the challenges discussed. For example, in "open review," reviewers and authors are informed of each other's identities, and reviewers' names are typically noted in published articles.^{6,9} It is thought that reviewers will be motivated to conduct higher quality reviews if they will receive recognition and their names will be publicly associated with published work. The natural concern with open review, however, is that the risk of bias increases with the disclosure of authors' identities. Publicly-identified reviewers may also be hesitant to provide negative reviews, even if warranted, out of fear of retribution or ill-treatment from displeased authors.⁹

As the Editors of JCEMS, we firmly stand by the JCEMS peer review process while acknowledging that all forms of peer review have advantages and drawbacks. We believe that double-blind peer review minimizes bias, promotes fairness, and encourages appropriate criticism. Despite concerns surrounding the motivation of reviewers in many fields, JCEMS is fortunate to be able to draw from an expanding community of scholars, many of whom have served in CBEMS organizations. Our reviewers are motivated to contribute to both the advancement of a growing field of research as well as the development of early-stage scholars.

Unfortunately, even motivated, experienced, and unbiased reviewers with relevant subject-matter expertise may fail to identify inaccuracies or areas for improvement in a manuscript; conversely, excellent reviewers may fail to identify the importance or innovation of a manuscript.¹ The peer-reviewed status of a JCEMS manuscript should never be relied on as the sole indicator of its quality, accuracy, or reliability. We encourage readers to critically appraise the work published in JCEMS and, in effect, perform their own review – readers must determine if the research design, interpretation of findings, and conclusions are appropriate and actionable. Readers are encouraged to develop, critique, and discuss the implications of published work through formal Letters to the Editor, which may be published in JCEMS, or through informal "comments" on our website. The peer review process should never be considered complete, but rather a continuous process pre- and post-publication.

Conclusions

The study of peer review is itself an evolving field of scientific inquiry. Researchers are actively investigating methods to improve quality and equity throughout the process.^{6,10} The JCEMS editorial team actively follows developments in the science of peer review, and we are open to modifying our process as new findings reveal opportunities for improvement.

While the JCEMS peer review process may develop over time, our commitment to promoting a research culture in the CBEMS community will remain constant. Peer review serves as a filter for publication and strengthens the quality of submitted content. Peer review is one tool in our arsenal to ensure that published CBEMS scholarship meets the level of accuracy, reliability, and credibility that the CBEMS community deserves.

Acknowledgments

We thank the Editorial Board for their contributions to the development of the JCEMS peer review process. We are also deeply grateful for all anonymous, independent reviewers who dedicated their time and expertise to contribute to collegiate EMS scholarship.

References

- Hames I. Peer Review and Manuscript Management in Scientific Journals: Guidelines for Good Practice. Malden, MA: Blackwell Publishing; 2007.
- International Committee of Medical Journal Editors. Recommendations for the Conduct, Reporting, Editing and Publication of Scholarly Work in Medical Journals. http://www.ICMJE.org. Updated November 29, 2018. Accessed February 15, 2019.

- Friedman NMG, Dingler BJ, Nable JV, Koenig GJ. Research and Scholarship in Collegiate Emergency Medical Services: Current State and Opportunities for Progress. *J Coll Emerg Med Serv.* 2018;1(1):5-12. https://doi. org/10.30542/JCEMS.2018.01.01.01
- Friedman NMG, Dingler BJ. The JCEMS Research Mentorship Program: Objectives and Opportunities. J Coll Emerg Med Serv. 2018;1(2):4-7. https:// doi.org/10.30542/JCEMS.2018.01.02.01
- Nature Publishing Group (No author listed). Review Rewards. Nature. 2014;514(7522):274. https://doi.org/10.1038/514274a
- 6. Rennie D. Make peer review scientific. *Nature*. 2016;535(7610):31-33. https://doi.org/10.1038/535031a
- Tomkins A, Zhang M, Heavlin WD. Reviewer bias in single- versus double-blind peer review. *PNAS*. 2017;114(48):12708-12713. https://doi. org/10.1073/pnas.1707323114
- Haug CJ. Peer-Review Fraud Hacking the Scientific Publication Process. N Engl J Med. 2015;373(25):2393-2395. https://doi.org/10.1056/ NEJMp1512330
- DeCoursey F. The pros and cons of open peer review [web-only perspective]. *Nature*. Published on-line 2006. https://doi.org/10.1038/nature04991
- Rennie D, Flanagin A. Three Decades of Peer Review Congresses. JAMA. 2018;319(4):350–353. https://doi.org/10.1001/jama.2017.20606

Author Affiliations: From *The Journal of Collegiate Emergency Medical Services*, Philadelphia, PA, USA (B.J.D., N.M.G.F); Physician Assistant Program, Drexel University College of Nursing and Health Professions, Philadelphia, PA, USA (B.J.D.).

Address for Correspondence: Brittany J. Dingler, BA, PA-S. *The Journal of Collegiate Emergency Medical Services*, 117 N 15th St., Philadelphia, PA 19102, USA. E-mail: JCEMS@CollegeEMS.com

Conflicts of Interest/Funding Sources: By the JCEMS Submission Declaration Form, all authors are required to disclose all potential conflicts of interest and funding sources. N.M.G.F and B.J.D. serve in uncompensated editorial roles for JCEMS. All authors declared that they have no others conflicts of interest. All authors declared that they did not receive funding to conduct the research and/or writing associated with this work.

Authorship Criteria: By the JCEMS Submission Declaration Form, all authors are required to attest to meeting the four ICMJE.org authorship criteria: (1) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND (2) Drafting the work or revising it critically for important intellectual content; AND (3) Final approval of the version to be published; AND (4) Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Submission History: Received February 15, 2019; accepted for publication February 15, 2019.

Published Online: February 21, 2019

Published in Print: February 22, 2019 (Volume 2: Issue 1)

Reviewer Information: In accordance with JCEMS editorial policy, Editorial manuscripts are reviewed by the JCEMS Editorial Board and published by the Editor-in-Chief or designee. JCEMS thanks the Editorial Board members who contributed to the review of this work.

Copyright: © 2019 Dingler & Friedman. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International (CC BY 4.0) License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. The full license is available at: https://creativecommons.org/licenses/by/4.0/

Electronic Link: https://doi.org/10.30542/JCEMS.2019.02.01.01

Prehospital Management of Hypoglycemic Emergencies:

Evidence-Based Review for Collegiate-Based Emergency Medical Services

Elizabeth V. Woodburn, BS, NREMT & Paul S. Rostykus, MD, MPH, FAEMS

ABSTRACT

Treatment of hypoglycemic emergencies may present a unique challenge to collegiate-based emergency medical services providers due to variations in patient presentations and available management options. While hypoglycemia can occur in a variety of settings, it is most commonly a complication of the treatment of diabetes. As the prevalence of diabetes in the general population continues to increase, providers are more likely to encounter patients experiencing hypoglycemic emergencies, necessitating familiarity with relevant protocols and treatment. This review discusses the pathophysiology and presentation of hypoglycemic emergencies, as well as assessment and treatment options across different scopes of practice for emergency medical services providers. Additional recommendations are provided for collegiate-based agencies regarding training and prevention.

KEYWORDS: altered mental status, collegiate-based emergency medical services, dextrose, glucagon, glucose, hypoglycemia, insulin

Corresponding Author and Author Affiliations: Listed at the end of this article.

ollegiate-based emergency medical services (CBEMS) providers must be vigilant in searching for potential causes of altered mental status in patients who appear to be intoxicated. Despite the high prevalence of alcohol usage in young adults, estimated at approximately 57% of those aged 18 to 25,1 hypoglycemia is one of the most common causes of altered mental status in the prehospital setting.² It is most often a complication of medications used to treat diabetes mellitus ("diabetes"); hypoglycemia may also occur acutely in the setting of reduced food intake in non-diabetics, and other less common causes include alcohol consumption, critical illnesses such as organ failure or sepsis, hormone deficiency, nonislet cell tumors, and endogenous hyperinsulinism.3 Concern for hypoglycemic emergencies is increasingly relevant - the prevalence of diabetes continues to increase globally⁴ and, as of 2015, the prevalence of diabetes in the United States in the 18-44 age group is estimated at 2.6%.5

Type 1 diabetes mellitus (T1DM) results from the destruction of insulin-producing beta cells, which is typically immune-mediated, requiring patients to administer insulin subcutaneously via intermittent injection or insulin pump infusion in order to maintain normal blood sugar levels (euglycemia). These insulin doses are calculated by the patient or the device to accommodate the intake of carbohydrates. T1DM accounts for approximately 5-10% of diabetes cases across all age groups.⁵ While recent data is lacking, trends show that the incidence of T1DM in youth ages 0-19 is increasing.⁶ It is estimated that over 53,000 students with T1DM attend college in the United States.⁷

Type 2 diabetes mellitus (T2DM) is characterized by chronically elevated blood glucose levels and is thought to occur as a result of the interaction of genetic and lifestyle-related factors. It is primarily characterized by insulin resistance in various tissues, necessitating abnormally high insulin levels in order to maintain euglycemia, and T2DM may be further complicated by abnormal insulin secretion. T2DM can be managed by a wider variety of medications; primary treatment involves oral metformin therapy and lifestyle changes. These can be supplemented with other medications including insulin or insulin secretagogues, which increase insulin secretion from functional beta cells.^{8,9}

Even with a history of good glycemic control, the process of adapting to a college environment presents unique challenges to the student with diabetes that can lead to an increased risk of hypoglycemia.^{7,10} In addition to changing daily routines, living away from home typically decreases the amount of diabetes management support and oversight provided by family members, who may be accustomed to frequently reminding the patient to check their blood sugar or asking about recent management trends.

The purpose of the current review is to discuss the pathophysiology and varied patient presentations of hypoglycemic emergencies, and to examine variations in the scope of practice of EMS providers when responding to hypoglycemic emergencies. We also explore the implications of assessment and treatment protocols for CBEMS providers and organizations. While recent hypoglycemia research has tended to focus on variations in treatment protocols for providers at the Intermediate Life Support (ILS) or Advanced Life Support

Elizabeth V. Woodburn, BS, NREMT is a student at the Carle Illinois College of Medicine and former Director of Education for Illini Emergency Medical Services. She has also worked as a Wilderness EMT while leading youth adventure trips. Her research interests include curriculum development and evaluation, as well as innovative point-of-care diagnostic devices.

Paul S. Rostykus, MD, MPH, FAEMS has been an EMS medical director for numerous ambulance and fire agencies in Southern Oregon over the past twentyfive years spanning large and small, rural and urban, as well as paid and volunteer organizations. In addition, Dr. Rostykus has been active in EMS at the regional, state, and national levels and is a member of the National Association of Emergency Medical Services Physicians (NAEMSP).

Learning Objectives

Understand the pathophysiology of hypoglycemic emergencies.

Recognize the varied clinical presentations of hypoglycemia.

Discuss evidence-based treatment guidelines for campus EMS providers at the BLS and ALS levels.

Identify recent revisions in scope of practice and areas in need of further research.

(ALS) level, less than 13% of registered CBEMS agencies operate at these levels of service.¹¹ We therefore place considerable attention on the critical role of Basic Life Support (BLS) providers and their expanding scope of practice for hypoglycemic emergencies. Since prehospital identification and treatment of severe hypoglycemia can improve patient outcomes and conserve healthcare resources by potentially reducing the need for transport to the emergency department,¹² review of prehospital hypoglycemia management is worthy of attention.

National Model Guidelines

Recently, an increased focus has been placed on developing evidence or consensus-based guidelines and models in order to promote quality care and consistent practice in the EMS community on a national scale. In this review, we explore two such documents in reference to prehospital hypoglycemia management: the *National Model EMS Clinical Guidelines*¹³ and the *National EMS Scope of Practice Model.*¹⁴⁻¹⁶

The *National Model EMS Clinical Guidelines* are developed by the Medical Directors Council of the National Association of State EMS Officials (NASEMSO). The *Guidelines* – based on the best available evidence and expert consensus, in the absence of sufficient evidence – provide a standardized model set of guidelines for patient care that can be adapted for use by leadership at the state, regional, or local level. The first version of the *Guidelines* was released by NASEMSO in 2014, and the current version (Version 2.1) was released in 2017 and updated in 2018.¹³

The *National EMS Scope of Practice Model* is also prepared by NASEMSO based on the scientific literature and, as necessary, expert opinion. ¹⁶ The *Practice Model* is not a regulatory document but serves as a uniform model and resource to assist individual states in defining the scope of practice of EMS providers in each state – the legal limits of the duties and services that providers at each level (eg, Emergency Medical Technician (EMT) vs. Paramedic) may perform.¹⁶ The *Practice Model* was initially released in 2007,¹⁴ and revised to accommodate new evidence in order to create the *2018 National EMS Scope of Practice Model*.¹⁶ As of January 2019, a pre-publication draft of the *2018 Practice Model* is publicly available,¹⁶ but the document is only considered "in effect" once officially approved and published by the National Highway Traffic Safety

Administration (NHTSA)¹⁷; however, in 2017, select revisions were incorporated into the 2007 Practice Model.¹⁵ Although the National Model EMS Clinical Guidelines and the National EMS Scope of Practice Model have been implemented to promote uniformity in practice, it is essential that providers refer to their State's scope of practice regulations as well as state, regional, and local clinical protocols.

Key Points

Hypoglycemia is defined as a blood glucose measurement below 60 mg/dL in NASEMSO's *National Model EMS Clinical Guidelines*.

Hypoglycemia may occur as a complication of diabetes treatment, although causes are varied.

Identification of hypoglycemia requires a thorough patient history and physical examination, including measurement of blood glucose levels per state/local protocols.

Treatment options include oral glucose, dextrose, and glucagon. Providers must be aware of all developments in their state/local protocols regarding treatment options.

Clinical Definitions and Mechanisms

Hypoglycemia is defined as a blood glucose measurement below 70 mg/dL by the American Diabetes Association (ADA)⁹ and below 60 mg/dL in NASEMSO's *National Model EMS Clinical Guidelines*.¹³ Severe hypoglycemia refers to a hypoglycemic event that a patient is unable to self-treat without assistance.¹⁸ A patient's ability to detect the onset of a hypoglycemic episode by identifying the presence of symptoms, rather than obtaining a low blood glucose measurement, is referred to as hypoglycemic awareness. Impairment of this awareness – also referred to as hypoglycemia-associated autonomic failure⁸ – results from deficiencies in counter-regulatory mechanisms, thereby compromising a patient's ability to identify and treat early hypoglycemia before it progresses to a severe episode.¹⁹

Glucose regulation is a complex process by which the body adjusts to variations in glucose supply and demand in order to maintain euglycemia, or normal blood sugar levels (Figure 1). In healthy individuals, endocrine tissue in the pancreas reacts to variations in blood glucose by adjusting secretion of the regulatory peptide hormones insulin and glucagon. Insulin, secreted by beta cells, decreases blood glucose levels by inducing cells in various tissues to increase their glucose uptake. Glucagon, secreted by alpha cells, works to increase the concentration of glucose in the blood by stimulating the liver to break down stored glycogen and activate gluconeogenesis, the process by which the body synthesizes glucose from organic molecules.

Hypoglycemia can occur in otherwise healthy individuals when this process is stressed by abnormal conditions, such as prolonged fasting or intense exercise, or in pathological states, such as diabetes. Treatment of diabetes with insulin or insulin secretagogues, such



Figure 1. Basic physiological process of glucose regulation. Image courtesy of National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health.

as sulfonylureas, are the most common causes of hypoglycemia.³ Over-administration of insulin can lead to rapid hypoglycemia and may occur, for example, when a patient overestimates the amount of carbohydrates in a meal or fails to eat as much as anticipated. Hypoglycemia often occurs during or shortly after exercise in patients treated with insulin, making unplanned exercise or strenuous physical activity a particular challenge for the patient with diabetes.³

The normal counter-regulatory response to hypoglycemia relies on decreased insulin secretion and activation of glucagon-producing alpha cells, as well as sympathoadrenal activation.³ This response is impaired in patients with T1DM. Even if the patient with T1DM recognizes hypoglycemia and halts or reduces insulin delivery, insulin already delivered will remain active in the body even as blood glucose levels continue to decrease. The ability of the pancreas to detect hypoglycemia and increase glucagon secretion is also impaired, thus compromising the pancreas's ability to restore normal glucose levels by activating glycogen stores.²⁰ Alcohol intake has been shown to further increase the risk of hypoglycemia, likely through impairment of gluconeogenesis, the counter-regulatory response, and hypoglycemia awareness.²¹

Clinical Presentation & Assessment

Although data on causes of altered mental status are mostly derived from emergency department data, a patient may present with altered mental status in the prehospital setting as a result of a neurologic, toxicologic, diabetic, or infectious condition.² The *National Model EMS Clinical Guidelines* for hypoglycemia management apply when a patient meets one or more of the following inclusion criteria: altered mental status, stroke symptoms, seizure, appearance of intoxication, suspected pediatric alcohol ingestion, history of diabetes, or a blood glucose level less than 60 mg/dL.¹³

Patients and providers alike can confirm hypoglycemia with a blood glucose measurement, usually obtained from a fingerstick blood sample, using a portable glucometer. The 2007 National EMS Scope of Practice Model includes blood glucose monitoring within the scope of practice of Advanced EMTs (AEMTs) and higher,¹⁴ but the 2018 Practice Model includes the skill within the scope of practice of EMTs and higher.¹⁶ A study published in 2018 revealed that most states do allow EMTs to measure blood glucose.²² In the absence of a blood glucose reading, local EMS protocols may allow for treatment of presumed hypoglycemia based on the presence of clinical symptoms in a patient with diabetes treated with insulin.²³

Providers should also be familiar with continuous glucose monitoring systems, which are implantable devices that allow patients with diabetes to obtain estimated blood glucose values as often as every few minutes. Implanted continuous monitors can provide useful information to patients about blood glucose trends. Between 2012 and 2017, continuous glucose monitor use rose from 7% to 28% across all age groups.²⁴ EMS providers should expect to encounter these systems more frequently as their popularity grows and recognize that the estimated glucose values these devices generate should be confirmed with a fingerstick glucometer determination.

Early recognition and treatment are critical in preventing negative outcomes such as confusion, seizures, coma, or death. Specific signs and symptoms can be categorized as neuroglycopenic, caused by glucose deprivation in the brain, or autonomic, triggered by sympathoadrenal activation (Table 1).^{8,25}

The signs and symptoms are not exclusive to hypoglycemia, demanding that EMS providers carefully consider alternate correctable causes of the patient's condition. In particular, a patient with alcohol or other drug intoxication, head injury, infection, stroke,

Table 1. Common signs and symptoms of hypoglycemia.^{8,25}

Neuroglycopenic	Autonomic
 Confusion Lethargy/Drowsiness Dizziness Combativeness/ Agitation Difficulty speaking Inability to concentrate Focal neurologic deficits Seizure Unresponsiveness 	 Sweating Palpitations Anxiety Nausea/Vomiting Tremor

seizure, or mental illness may also present with altered mental status and other comparable signs and symptoms.² Individual experiences of hypoglycemia vary by patient, such that the appearance of certain symptoms or degrees of altered mental status do not universally appear at defined blood glucose levels.¹⁸ In addition to blood glucose monitoring, patient assessments should include a secondary survey of findings pertinent to hypoglycemia, including the presence of an insulin pump, tachycardia and hypotension, sunken eyes and dry mucus membranes from dehydration, or tongue bite from seizure. Neurological assessment should include Glasgow Coma Score (GCS), mental status, and focal motor or sensory deficits.¹³

Guidelines for Treatment

For a patient confirmed to be hypoglycemic, several options for prehospital treatment exist: oral glucose, intravenous (IV) or intraosseous (IO) dextrose, and intramuscular (IM) or intranasal (IN) glucagon. Despite treatment recommendations being based on the *National Model EMS Clinical Guidelines*,¹³ readers should always consult local protocols and medical direction.

Oral Glucose

When the patient is conscious and capable of protecting their airway, oral glucose administration is often the most appropriate treatment for hypoglycemia. Certain state or local protocols may also permit the administration of small amounts of oral glucose between the cheeks and gums of a patient who cannot swallow but who has an intact gag reflex.²⁶ Both the 2007 and 2018 National EMS Scope of Practice Models include administration of oral glucose within the scope of practice of EMTs and higher.^{14,16} The National Model EMS Clinical Guidelines recommend administration of 25 g to adults and 0.5-1 g/kg to pediatric patients when blood glucose is less than 60 mg/dL.13 Administration of oral glucose can be repeated if hypoglycemia persists.8 ADA treatment guidelines for patients with diabetes recommend administration of 15-20 g of oral glucose when blood glucose is <70 mg/dL,⁹ which is equivalent to approximately 8 ounces of orange juice. EMS agencies commonly utilize prepackaged doses of glucose gel due to its ease of administration, extended shelf life, and cost of only a few dollars; glucose tablets or sugary foods such as cake icing may also be used.13

Dextrose

In situations where oral administration is contraindicated, intravenous (IV) dextrose (D-glucose) solutions and, per local protocols, intraosseous (IO) dextrose are alternative treatment options for increasing blood glucose levels. While these methods of delivery are fast-acting, difficulties in establishing access due to complex presentation (eg, reduced IV access in the setting of dehydration) or provider inexperience may delay treatment. Both the 2007 and 2018 *National EMS Scope of Practice Models* include establishment of IV or IO access within the scope of practice of AEMTs and Paramedics.¹⁶ Dextrose should be administered in incremental doses until patient mental status improves with a maximum dose of 25 g for adults and 0.5-1 g/kg for pediatrics. Since most collegiate-based EMS agencies operate at the BLS level,¹¹ dextrose is not commonly utilized in this setting.

Further variations in local protocols and usage exist regarding

the strength of dextrose solution indicated. In a 2016 survey of protocols from EMS agencies across the United States, 70% of protocols specified 50% dextrose (D50) solution in adult hypoglycemic patients, 8% specified 10% dextrose solution (D10), and the remaining 22% of protocols permitted the use of either.²⁷ The National Model EMS Clinical Guidelines suggest that a concentration of no more than 25% be used in children less than 8 years old, and no more than 12.5% in neonates and infants less than 1 month old.¹³ D10 solution is becoming more commonly used due to its lower risk of tissue necrosis should extravasation occur, diminished risk of hyperglycemia due to overcorrection of hypoglycemia, and lower cost relative to D50.² Recent observational cohort studies of patients receiving D10^{28,29} and a randomized controlled trial comparing D10 and D50³⁰ have demonstrated that D10 administration is safe and effective for adults. Although data is limited, in the randomized controlled trial there were no significant differences between median post-treatment GCS, time to recovery, or the proportion of patients experiencing another hypoglycemic episode within 24 hours of treatment.³⁰ Using D10 exclusively also eliminates the need to dilute D50 for use in pediatric patients in order to prepare a solution with lower risk of vascular injury.8 This may be particularly advantageous for CBEMS providers who may have less familiarity with pediatric protocols and dilution calculations.

Glucagon

In the absence of venous access, including the inability to obtain it due to limited scope of practice, most agency protocols allow for usage of intramuscular (IM) glucagon to treat hypoglycemia.²⁷ Nausea and vomiting have been reported as side effects, but the risk is small and may occur due to hypoglycemia regardless of glucagon administration.¹⁸ The *National Model EMS Clinical Guidelines* recommend a dose of 1 mg for adults and pediatric patients who weigh at least 20 kg (or greater than 5 years of age), and 0.5 mg for those under 20 kg (or less than 5 years of age).¹³ ADA treatment guidelines for patients with diabetes recommend that all persons at risk for severe hypoglycemia should be prescribed IM glucagon, and that caregivers or family members should know how to administer it.⁹ As such, EMS providers may find that the patient's own prescribed glucagon is present on scene and local protocols may allow use of the patient's own medication.

Glucagon releases glucose from internal stores of glycogen but does not provide an external supply of glucose as oral or hypertonic glucose do. This reduces its effectiveness in patients who have depleted their glycogen stores during a recent period of alcohol consumption, fasting, or low carbohydrate intake, as well as in malnourished patients or frequent users of alcohol.^{21,31-33} Hypoglycemic patients treated with glucagon will usually require transport to and additional evaluation in the emergency department or appropriate medical facility. While administration of IV glucose has been shown to lead to faster recovery from hypoglycemia, utilizing IM glucagon instead may cause a more stable rise in blood sugar.^{32,34}

As per both the 2007 and 2018 National EMS Scope of Practice Models, the IM route of medication administration is only within the scope of practice of AEMTs and Paramedics.¹⁶ Although IM glucagon is typically administered via a glucagon kit that contains a syringe and vial,³⁵ intranasal (IN)³⁶ and auto-injector IM³⁷ formulations for glucagon have undergone phase 3 clinical trails –as of 2017, unit dose, premeasured, IN or auto-injector IM medications are also within the scope of practice of EMTs and even emergency medical responders (EMRs).^{15,16}

According to a study published in 2018, that includes data obtained from state EMS offices, only 8 states allow EMTs to administer glucagon.²² As a point-of-comparison, a 2017 study found that 13 states allow EMTs to administer IM epinephrine via syringe epinephrine kits instead of epinephrine auto-injectors.³⁸ Expansion of state protocols regarding glucagon administration and future commercial availability of novel auto-injector and IN glucagon administration devices may allow for more widespread administration of glucagon in the prehospital setting. However, additional training would be necessary to ensure that glucagon is administered safely and effectively by EMTs or EMRs. The cost of glucagon also needs to be considered when evaluating options for increasing access to glucagon, particularly in the collegiate setting. At an average cost of \$212 per 1 mg dose²² and shelf life of 24 months from the date of manufacture,35 stocking glucagon can significantly impact an EMS agency's finances, and novel auto-injector or IN devices may be expensive.

Reassessment & Transport

After treatment has been administered, reassessment of the patient's vital signs and mental status is essential. National clinical guidelines suggest that repeat blood glucose monitoring should be performed if hypoglycemia and altered mental status persist but is not needed if mental status has returned to normal. If a maximal field dosage of dextrose solution has been administered and the patient does not achieve normal blood glucose levels and mental status, transport to an appropriate facility should be initiated while alternative causes of altered mental status are investigated.¹³

A recently published study, relying on 2013 data from the National EMS Information System (NEMSIS) and additional national surveys, found that approximately 20% of patients who are treated for hypoglycemia in the prehospital setting are not transported from the scene.¹² Although recent data is lacking, several studies suggest that non-transport can be safe, particularly in the context of structured "treat and release" protocols.³⁹⁻⁴³ The *National Model of EMS Clinical Guidelines* states that if hypoglycemia resolves after treatment, release without transport may be considered if all eight conditions are met (Table 2).¹³ Providers should follow relevant protocols to facilitate the transfer of patients to higher levels of care when needed, including in cases of hypoglycemia that fail to respond to treatment.

Continued research may further identify patients who may have poor outcomes without transport to the emergency department. Further research is also needed to determine whether college students with diabetes are at a greater short term risk for repeat episodes of severe hypoglycemia after prehospital treatment without transport.

Conclusions

CBEMS providers may be likely to encounter hypoglycemic emergencies and must be knowledgeable of assessment strategies and appropriate treatment options. Hypoglycemia presents an opportunity where early identification and treatment can lead to a relatively rapid reversal of symptoms and prevention of negative and fatal outcomes. Furthermore, the expansion of the EMT scope of practice to include blood glucose measurement and, variably, IM glucagon administration increases the resources available to providers for managing these scenarios. Implementing protocols based on evidence-based national guidelines, when available, promotes greater quality and consistency between EMS organizations.

Collegiate EMS supervisors, training officers, and scholars can also promote prevention and quality management of hypoglycemic emergencies through the development of novel trainings, public health initiatives, and research projects. We recommend that collegiate EMS agencies participate in training scenarios involving cases

Table 2. Requisite criteria for non-transport of hypoglycemic patients, as recommended by national clinical guidelines.¹³

"Treat and Release" Criteria*

- 1. Repeat glucose is greater than 80 mg/dL.
- 2. Patient takes insulin or metformin to control diabetes.
- 3. Patient returns to normal mental status, with no focal neurologic signs/symptoms after receiving glucose/dextrose.
- 4. Patient can promptly obtain and will eat a carbohydrate meal.
- 5. Patient or legal guardian refuses transport and EMS providers agree that transport is not indicated.
- 6. A reliable adult will be staying with the patient.
- 7. No major co-morbid symptoms exist, such as chest pain, shortness of breath, seizures, or intoxication.
- 8. A clear cause of the hypoglycemia is identified (eg, missed meal).

*All criteria must be met in order for patient to be released from medical care without transport to the emergency department.

of altered mental status that include hypoglycemia, and practice with in-service glucometer models when included in protocols. Agencies could also participate in public health outreach by working with campus health services to promote awareness and to increase the number of students wearing identification bracelets for medical conditions, especially T1DM. Further research is also needed to establish the prevalence of T1DM and T2DM in collegiate populations, as well as the frequency of hypoglycemic emergencies encountered by CBEMS agencies.

References

- Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration. Key Substance Use and Mental Health Indicators in the United States: Results from the 2016 National Survey on Drug Use and Health.. https://www.samhsa.gov/data/report/key-substanceuse-and-mental-health-indicators-united-states-results-2016-national-survey. Published September 2017. Accessed February 7, 2019.
- Sanello A, Gausche-Hill M, Mulkerin W, et al. Altered Mental Status: Current Evidence-based Recommendations for Prehospital Care. West J Emerg Med. 2018;19(3):527-541. https://doi.org/10.5811/westjem.2018.1.36559
- Cryer PE, Axelrod L, Grossman AB, et al. Evaluation and Management of Adult Hypoglycemic Disorders: An Endocrine Society Clinical Practice Guideline. *J Clin Endocrinol Metab.* 2009;94(3):709-728. https://doi. org/10.1210/jc.2008-1410
- Maffi P, Secchi A. The Burden of Diabetes: Emerging Data. Dev Opthamology. 2017;60:1-5. https://doi.org/10.1159/000459641
- National Center for Chronic Disease Prevention and Health Promotion, Center for Disease Control and Prevention. National Diabetes Statistics Report, 2017. https://www.cdc.gov/diabetes/pdfs/data/statistics/nationaldiabetes-statistics-report.pdf. Published 2017. Accessed February 7, 2019.
- Mayer-Davis EJ, Lawrence JM, Dabelea D, et al. Incidence Trends of Type 1 and Type 2 Diabetes among Youths, 2002-2012. N Engl J Med. 2017;376(15):1419-1429. https://doi.org/10.1056/NEJMoa1610187
- Monaghan M, King MM, Alvarez V, Cogen FR, Wang J. Changes in Type 1 Diabetes Health Indicators from High School to College. J Am Coll Health. 2016;64(2):157-161. https://doi.org/10.1080/07448481.2015.1068780
- Jalili M, Niroomand M. Type 2 Diabetes Mellitus. In: Tintinalli JE, Stapczynski S, Ma OJ, Yealy DM, Meckler GD, Cline DM, eds. *Tintinalli's Emergency Medicine*. 8th ed. New York, NY: McGraw-Hill Education; 2016.
- Association AD. Standards of Medical Care in Diabetes—2018 Abridged for Primary Care Providers. *Clin Diabetes*. 2018;36(1):14-37. https://doi. org/10.2337/cd17-0119
- Mellinger DC. Preparing Students With Diabetes for Life at College. *Diabetes Care*. 2003;26(9):2675-2678. https://doi.org/10.2337/diacare.26.9.2675
- National Collegiate Emergency Medical Services Foundation. United States EMS Organizations. https://www.ncemsf.org/resources/ems-organizationdatabase/groups-listed-by-region/united-states-ems-organizations. Accessed December 12, 2018.
- Kaufmann M, Nelson D, Kaushik P, Mann N, Mitchell B. Hypoglycemia Emergencies: Factors Associated with Prehospital Care, Transportation Status, Emergency Department Disposition, and Cost [published online ahead of print November 2, 2018]. *Prehosp Emerg Care*. 2018. https://doi.org/10.1080/ 10903127.2018.1528322
- Medical Directors Council, National Association of State EMS Officials. National Model EMS Clinical Guidelines: Version 2.1. https://nasemso. org/wp-content/uploads/National-Model-EMS-Clinical-Guidelines-2017-

Version2.1-29June2018-1.pdf. Published September 7, 2017. Updated June 29, 2018. Accessed February 7, 2019.

- National Highway Traffic Safety Administration. 2007 National EMS Scope of Practice Model. https://www.ems.gov/education/EMSScope.pdf. Published February 2007. Accessed February 7, 2019.
- National Highway Traffic Safety Administration. 2007 National EMS Scope of Practice Model: Including Change Notices 1.0 and 2.0. https://www.ems. gov/pdf/2017-National-EMS-Scope-Practice-Mode_Change-Notices-1-and-2. pdf. Published December 2017. Accessed February 7, 2019.
- National Highway Traffic Safety Administration. 2018 National EMS Scope of Practice Model: Prepublication Display Copy. https://nasemso.org/wpcontent/uploads/Prepublication-Display-Copy-2018-National-EMS-Scope-of-Practice-Model-20180929.pdf. Published September 2018. Accessed February 7, 2019.
- 17. National Association of State EMS Officials. EMS Scope of Practice. https:// nasemso.org/projects/ems-scope-of-practice/. Accessed February 7, 2019.
- Kedia N. Treatment of severe diabetic hypoglycemia with glucagon: an underutilized therapeutic approach. *Diabetes Metab Syndr Obes*. 2011;4:337-346. https://doi.org/10.2147/DMSO.S20633
- Iqbal A, Heller S. Managing hypoglycaemia. *Clin Endocrinol Metab.* 2016;30(3):413-430. https://doi.org/10.1016/j.beem.2016.06.004
- Tesfaye N, Seaquist ER. Neuroendocrine Responses to Hypoglycemia. *Ann N Y Acad Sci.* 2010;1212:12-28. https://doi.org/10.1111/j.1749-6632.2010.05820.x
- Tetzschner R, Norgaard K, Ranjan A. Effects of alcohol on plasma glucose and prevention of alcohol-induced hyopglycemia in type 1 diabetes- A systematic review with GRADE. *Diabetes Metab Res Rev.* 2018;34(3):e2965. https://doi. org/10.1002/dmrr.2965
- Kahn P, Wagner N, Gabbay R. Underutilization of Glucagon in the Prehospital Setting. Ann Intern Med. 2018;168(8):603-604. https://doi. org/10.7326/M17-2222
- Carle Regional EMS. Protocols: Adult Medical Emergencies. https://carle.org/ locations/carle-foundation-hospital/emergency-services/regional-ems/emsdocuments/adult-medical-emergencies-0816.pdf. Published January 2016. Accessed February 7, 2019.
- Foster NC, Miller K, Dimeglio L, et al. Marked Increases in CGM Use Has Not Prevented Increases in HbA1c Levels in Participants in the T1D Exchange (T1DX) Clinic Network. *Diabetes*. 2018;61(suppl 1):1689-P. https://doi.org/10.2337/db18-1689-P
- Goyal N, Schlichting AB. Type 1 Diabetes Mellitus. In: Tintinalli JE, Stapczynski S, Ma OJ, Yealy DM, Meckler GD, Cline DM, eds. *Tintinalli's Emergency Medicine*. 8th ed. New York, NY: McGraw-Hill Education; 2016.
- Bureau of Emergency Medical Services, Pennsylvania Department of Health. Pennsylvania Statewide Basic Life Support Protocols. http://pehsc.org/wpcontent/uploads/2014/05/FINAL-2017-BLS-PROTOCOL.pdf. Published June 10, 2017. Accessed February 7, 2019.
- Rostykus P, Kennel J, Fillinger M, et al. Variability in the Treatment of Prehospital Hypoglycemia: A Structured Review of EMS Protocols in the United States. *Prehosp Emerg Care*. 2016;20(4):524-530. https://doi.org/10.31 09/10903127.2015.1128031
- Hern HG, Kiefer M, Louie D, Barger J, Alter HJ. D10 in the Treatment of Prehospital Hypoglycemia: A 24 Month Observational Cohort Study. *Prehosp Emerg Care.* 2017;21(1):63-67. https://doi.org/10.1080/10903127.2016.11 89637
- Kiefer M V., Hern GH, Alter HJ, Barger JB. Dextrose 10% in the treatment of out-of-hospital hypoglycemia. *Prehosp Disaster Med.* 2014;29(2):190-194.

https://doi.org/10.1017/S1049023X14000284

- Moore C, Woollard M. Dextrose 10% or 50% in the treatment of hypoglycaemia out of hospital? A randomized controlled trial. *Emerg Med J.* 2005;22(7):512-515. https://doi.org/10.1136/emj.2004.020693
- Ranjan A, Schmidt S, Damm-Frydenberg C, et al. Low-Carbohydrate Diet Impairs the Effect of Glucagon in the Treatment of Insulin-Induced Mild Hypoglycemia: A Randomized Crossover Study. *Diabetes Care*. 2017;40(1):132-135. https://doi.org/10.2337/dc16-1472
- 32. Carstens S, Sprehn M. Prehospital treatment of severe hypoglycaemia: a comparison of intramuscular glucagon and intravenous glucose. *Prehosp Disaster Med.* 1998;13(2-4):44-50. https://www.cambridge.org/core/journals/prehospital-and-disaster-medicine/article/prehospital-treatment-of-severe-hypoglycaemia-a-comparison-of-intramuscular-glucagon-and-intravenous-gluc ose/3971417C7806A49A1F5C73F697F2B15F. Accessed February 7, 2019.
- Ranjan A, Norgaard K, Tetzschner R, et al. Effects of Preceding Ethanol Intake on Glucose Response to Low-Dose Glucagon in Individuals With Type 1 Diabetes: A Randomized, Placebo-Controlled, Crossover Study. *Diabetes Care*. 2018;41(4):797-806. https://doi.org/10.2337/dc17-1458
- Patrick AW, Collier A, Hepburn DA, Steedman DJ, Clarke BF, Robertson C. Comparison of intramuscular glucagon and intravenous dextrose in the treatment of hypoglycaemic coma in an accident and emergency department. *Arch Emerg Med.* 1990;7(2):73-77. https://doi.org/10.1136/emj.7.2.73
- Cobb E, Watson N, Wardian J, Morrow C, Sauerwein T. Glucagon kits: are your patients prepared for a hypoglycemic emergency? *AADE Pract*. 2017;5(1):12-17. https://doi.org/10.1177/2325160316677575
- 36. Seaquist ER, Dulude H, Zhang XM, et al. Prospective study evaluating the use of nasal glucagon for the treatment of moderate to severe hypoglycaemia in adults with type 1 diabetes in a real-world setting. *Diabetes Obes Metab.* 2018;20(5):1316-1320. https://doi.org/10.1111/dom.13278
- 37. Christiansen MP, Cummins MJ, Prestrelski SJ, Strange P. A Phase 3 Comparison of a Novel Liquid Glucagon Autoinjector to Glucagon Emergency Kit for the Symptomatic Relief of Severe Hypoglycemia. Diabetes. 2018;67(suppl 1):304-OR. https://doi.org/10.2337/db18-304-OR
- Brasted ID, Dailey MW. Basic Life Support Access to Injectable Epinephrine across the United States. *Prehosp Emerg Care*. 2017;21(4):442-447. https:// doi.org/10.1080/10903127.2017.1294224
- Roberts K, Smith A. Outcome of diabetic patients treated in the prehospital arena after a hypoglycaemic episode, and an exploration of treat and release protocols: a review of the literature. *Prehosp Med.* 2003;20:274-276. https:// doi.org/10.1136/emj.20.3.274
- Carter AJ, Keane PS, Dreyer JF. Transport refusal by hypoglycemic patients after on-scene intravenous dextrose. *Acad Emerg Med.* 2002;9(8):855–857. https://doi.org/10.1197/aemj.9.8.855
- 41. Holstein A, Plaschke A, Vogel MY, Egberts EH. Prehospital management

of diabetic emergencies--a population-based intervention study. Acta *Anaesthesiol Scand*. 2003;47(5):610–615. https://doi.org/10.1034/j.1399-6576.2003.00091.x

- Mattila EM, Kuisma MJ, Sund KP, Voipio-Pulkki LM. Out-of-hospital hypoglycaemia is safely and cost-effectively treated by paramedics. *Eur J Emerg Med.* 2004;11(2):70–74. Accessed February 7, 2019.
- Cain E, Ackroyd-Stolarz S, Alexiadis P, Murray D. Prehospital hypoglycemia: the safety of not transporting treated patients. *Prehosp Emerg Care*. 2003;7(4):458–465.

Author Affiliations: From Carle Illinois College of Medicine, Urbana, IL, USA (E.V.W.); Department of Emergency Medicine, Oregon Health and Science University, Portland, OR, USA (P.S.R.).

Address for Correspondence: Elizabeth V. Woodburn, BS, NREMT. E-mail: woodbrn2@illinois.edu.

Conflicts of Interest/Funding Sources: By the JCEMS Submission Declaration Form, all authors are required to disclose all potential conflicts of interest and funding sources. All authors declared that they have no conflicts of interest. All authors declared that they did not receive funding to conduct the research and/or writing associated with this work.

Authorship Criteria: By the JCEMS Submission Declaration Form, all authors are required to attest to meeting the four ICMJE.org authorship criteria: (1) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND (2) Drafting the work or revising it critically for important intellectual content; AND (3) Final approval of the version to be published; AND (4) Agreement to be accountable for all aspects of the work are appropriately investigated and resolved.

Submission History: Received December 19, 2018; accepted for publication February 7, 2019.

Published Online: February 21, 2019.

Published in Print: February 22, 2019 (Volume 2: Issue 1)

Reviewer Information: In accordance with JCEMS editorial policy, Clinical Review manuscripts undergo double-blind peer-review by at least two independent reviewers. JCEMS thanks the anonymous reviewers who contributed to the review of this work.

Copyright: © 2019 Woodburn & Rostykus. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International (CC BY 4.0) License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. The full license is available at: https://creativecommons.org/licenses/by/4.0/

Electronic Link: https://doi.org/10.30542/JCEMS.2019.02.01.02



Seeking original content for JCEMS: the official **scholarly, peer-reviewed journal** of the National Collegiate Emergency Medical Services Foundation. Visit **CollegeEMS.com** to learn how you can contribute to the growing field of collegiate EMS research.

Non-Veterinary Emergency Care of Law Enforcement Canines at Mass Gathering Events:

A Pilot Training Course for Collegiate-Based EMS Providers

Caroline Tonozzi, DVM, DACVECC; Maureen McMichael, DVM, DACVECC; Ashley Mitek, DVM; William Weir, MD, FACEP, FAEMS; Michael Smith, MD, FAEMS; Nathan Cornwell

ABSTRACT

Background: Law enforcement canines (LEK9s) are increasingly present for security and surveillance at marathons and other mass gathering events (MGEs). Dependent on state laws, non-veterinary collegiate-based emergency medical services (CBEMS) providers may be able to provide emergency care to LEK9s in the event of illness or injury. In preparation for the 2018 Illinois Marathon, we delivered a one-hour training course on LEK9 emergency care to providers of Illini EMS (IEMS) at the University of Illinois at Urbana-Champaign. The objective of this report is to describe the development, implementation, and evaluation of the training course. Case Report: At the request of IEMS, the training course was developed through a collaboration between a representative of IEMS, two emergency physicians, and three veterinary specialists. The first 30 minutes of the course included a presentation with information on triage and assessment in the field, blast injuries, opioid/toxin exposure, heat-related illness, artificial ventilation, and cardiopulmonary-resuscitation (CPR). The remainder of the course included hands-on training in which providers practiced palpating a pulse, administering artificial ventilations, and providing CPR on a K9 manikin. The course was evaluated via a post-course survey to identify areas for course improvement. Conclusions: To our knowledge, this is the first publication describing a training course for CBEMS providers in the identification and management of medical emergencies in LEK9s. Planned improvements for future courses include incorporation of multimedia, live animal training, and additional hands-on training with critical care and/or emergency veterinarians. CBEMS organizations may consider adapting the course in preparation for MGEs in consultation with veterinary specialists.

KEYWORDS: canine, collegiate-based emergency medical services, event medicine, law enforcement, massgathering medical care

Corresponding Author and Author Affiliations: Listed at the end of this article.

istorically, the finish line of a marathon has been a place of celebration and triumph for both the runners and spectators. Celebration transformed into tragedy when two homemade bombs detonated at the finish line of the Boston Marathon on April 15, 2013. The terrorist act killed 3 people and injured an additional 281 runners and spectators.¹ As a result of the mass casualty incident (MCI), there has been an increased focus on security and surveillance at marathons and other mass gathering events (MGEs), traditionally defined as events with 1,000 or more persons

Caroline Tonozzi, DVM, DACVECC is an Assistant Clinical Professor of Emergency/Critical Care in the Department of Veterinary Clinical Medicine at the University of Illinois College of Veterinary Medicine. Dr. Tonozzi is also a diplomate of the American Veterinary College of Emergency and Critical Care. Dr Tonozzi, **Maureen McMichael**, DVM, DACVECC, **Ashley Mitek**, DVM, **William Weir**, MD, FACEP, FAEMS, and **Michael Smith**, MD, FAEMS all serve on the Joint Task Force on Working Dog Care and Transport (Carle Foundation Hospital; Urbana, IL) to develop protocols for dealing with emergencies in LEK9s at mass gathering events. **Nathan Cornwell** is the President of Illini Emergency Medical Services at the University of Illinois-Urbana/Champaign. in a specific location for a specified period of time.² In particular, law enforcement canines (LEK9s) are now frequently included on security teams at MGEs. LEK9s have numerous assignments, including explosives and narcotics detection, patrol, tracking, apprehension and arrest, and search and rescue. Their versatility stems from their keen sense of smell, ability to navigate inaccessible areas, and ability to search a given area approximately 50 times faster than a human.³⁻⁷

LEK9s working at marathon or other MGEs may suffer from an acute illness or injury, particularly if an MCI occurs due to a violent attack (eg, bombing, active shooter incident) or a natural cause (eg, extreme weather, structural collapse). At select, high-profile events and exercises, veterinary medical professionals may be present onsite to provide immediate treatment. For example, National Veterinary Response Teams are deployed for National Special Security Events such as political conventions, presidential inaugurations, and the United Nations General Assembly. While increasing the presence of veterinary medical professionals at MGEs is worthy of attention, professional veterinary support is not routinely available at most MGEs with LEK9s on site. Non-veterinary medical staff may be able to provide basic emergency care to LEK9s depending on state laws and regulations.⁸ On-site medical staff at MGEs might include emergency medical services (EMS) providers, emergency physicians, advanced practice providers, nurses, and physical therapists.⁹ Notably, the presence of collegiate- or campus-based EMS (CBEMS) providers at MGEs has been recently described in the literature.¹⁰⁻¹² CBEMS providers may be involved in the planning, management, and provision of care at MGEs on university and college campuses¹⁰⁻¹²; however, CBEMS providers should receive additional training in order to safely and effectively identify and manage medical emergencies in LEK9s. To our knowledge, there are no prior publications describing the training of CBEMS providers in the identification and management of medical emergencies in LEK9s.

Illini EMS (IEMS), a CBEMS organization at the University of Illinois Urbana-Champaign (UIUC), routinely staffs MGEs. In preparation for the 2018 Christie Clinic Illinois Marathon, we delivered a one-hour pilot training course on LEK9 emergency care to IEMS providers. The objective of this report is to describe the development, implementation, and evaluation of the course.

Case Report

Illini EMS at the Illinois Marathon

Illini EMS (IEMS) is a basic life support (BLS), non-transporting, CBEMS organization located at the University of Illinois Urbana-Champaign (UIUC). IEMS serves as an organization within the Illinois Fire Institute and is staffed by volunteer undergraduate students. IEMS volunteers staff the Christie Clinic Illinois Marathon, a United States Track and Field (USTAF)-certified course covering the streets of Urbana-Champaign with approximately 7,000 participants. IEMS student leadership is involved in event preparations, including planning team placement and the number of volunteers needed. At the event, IEMS provides medical care at the finish line at Memorial Stadium on campus and via bicycle throughout the race course. Additional medical staff on-site include: emergency medical technicians (EMTs) from two fire departments, paramedics from two advanced life support (ALS) ambulance companies, emergency department and intensive care unit nurses on the course and at the finish line, and emergency physicians in the field hospital at the finish line in Memorial Stadium. The start/finish line of the marathon is located near a tertiary veterinary referral hospital (University of Illinois College of Veterinary Medicine) with 24-hour emergency and critical care capacity - transport of an affected animal to this facility could be performed if additional treatment was required.

Development and Design of Training

IEMS student leadership requested training on the identification and management of medical emergencies in LEK9s working at the 2018 Illinois Marathon. The IEMS providers reportedly had no prior experience or training in the handling of LEK9 medical emergencies. A panel including a CBEMS representative, two emergency physicians, two board certified veterinary specialists in emergency and critical care, and a board eligible veterinary specialist in anesthesiology evaluated the most likely LEK9 emergency scenarios to occur during the marathon. A training protocol was then created to provide training on recognition and emergency treatment for these conditions, including: heat-related illness, opioid/toxin exposure, blast injury, respiratory distress, and cardiopulmonary arrest (CPA)

The training course was held on the UIUC campus three weeks before the 2018 Christie Clinic Illinois Marathon. The hour-long course was run by two board-certified veterinary specialists in emergency and critical care. Twenty IEMS members attended. The course started with a 30-minute PowerPoint presentation covering a range of topics, including: triage and assessment in the field, opioid/toxin exposure, blast injuries, heat-related illness, identification of CPA, and performance of cardiopulmonary resuscitation (CPR) (Table 1). Images of dogs were provided to attendees detailing physical landmarks for assessment of vital signs. Figures were also provided with examples of dogs in appropriate positions for CPR. In addition, instructions – translated from veterinary CPR guidelines – were provided on positioning of the dog, hand position, depth of compressions, and number of compressions per minute (Table 2).^{13,14}

After the presentation, the twenty participants were arranged into two separate groups for hands-on training under direct guidance from board-certified veterinary specialists in emergency and critical care. Each group had a K9 CPR manikin (Rescue Critters[®] Dog Veterinary Training Manikin; Simi Valley, CA) available for practicing BLS CPR, proper placement of an oxygen face mask, and basket muzzle placement. The participants could ask questions from the veterinary specialists at any time during or immediately after the event.

Evaluation and Improvement

In order to guide future course improvements, an online survey was distributed via email after the training and available for 24 hours. No continuing education credit or other incentives were offered in return for answering the survey. Approval was received from the Institutional Review Board of UIUC. The following questions were included in the post-training survey, to be answered free form by the participants.

- What were your favorite aspects of the training event?
- How would you adjust the length of the event?
- How would you adjust the ratio of lecture to hands-on practice?
- What aspects of the training event could be improved?

Six out of twenty attendees (30%) completed the survey. All six respondents (100%) reported that the hands-on portion was the best part of the training course. Four of six (67%) answered that they would have preferred a higher ratio of hands-on practice to lecture, with two (33%) answering that the time allotted for each was sufficient. In addition, all six respondents (100%) reported wanting a longer training event. Answers received regarding aspects for improvement included requests for more background information on CPR, more information on how to translate the training if there are no canines or manikins available, more time practicing chest compressions, and availability of a concise outline of the PowerPoint to follow along. Anecdotally, the instructors noted that the participants really enjoyed time with the CPR manikin and would have appreciated additional time to practice chest compressions and placement of a face mask.

Based on this feedback, we plan to include additional time for hands-on training with the CPR manikin in the future and to potentially include training with a live dog. The CBEMS organization

Table 1. Outline of the Pilot Training CoursePowerPoint Presentation

Triage and Assessment in the Field

- Normal vital signs and physiological parameters
- Basic physical exam and assessment (including images)

Opioid/Toxin Exposure

- Clinical signs of exposure
- Administration of naloxone

Blast Injury

- Brief overview
- Primary, Secondary, Tertiary and Quaternary Injuries
- Common injuries and organ-systems affected

Heat-Related Illness

- Definition
- Pathophysiology
- Clinical Signs and Identification
- Treatment

Cardiopulmonary Arrest

- Definition
- Introduction to canine models for CPR
- Compressions
- Artificial Ventilations

might also purchase their own canine CPR manikin (cost approximately \$300-\$1500). The training could be split into two, one-hour sessions in the future, with the option for participants to return for additional training.

Discussion

Legislation of Medical Care for Animals by Non-Veterinarians

Legislation that provides authority and liability protection for the medical treatment and transport of LEK9s and other animals by non-veterinarians, including EMS providers, varies widely from state to state. ⁸ To date, most states do not permit medical treatment or transport of animals by non-veterinary personnel. Treatment and/or transport may violate a given state's veterinary practice acts, EMS statutes and protocols, or "Good Samaritan Laws."8 Working Dog HQ, a veterinarian-led organization dedicated to preventing canine opioid overdoses, maintains a database of relevant legislation (https://workingdoghq.com/legislation-update/). According to the organization, as of February 2019, legislation in Ohio, Colorado, Maryland, Wisconsin, New York, Mississippi, California, and Illinois permits treatment and/or transport of select animals by non-veterinarians in select instances. In Illinois, recent legislation now permits EMS providers to transport an LEK9 injured in the line of duty to a veterinary clinic if no humans require medical care or transport at the same time.

According to Working Dog HQ, additional legislation is under consideration or pending approval in numerous states, including New Jersey, New York, Pennsylvania, Washington, Massachusetts, and South Carolina. The expansion of such legislation throughout the U.S. – coupled with the careful development of treatment and transport protocols – may provide greater access to emergency medical care for the LEK9s who serve and protect us. CBEMS providers should actively follow the development of relevant legislation in their state and consider advocating for the expansion of legislation that protects LEK9s.

Given the current state of affairs, readers should acknowledge that the following recommendations and descriptions are provided for educational purposes only. The information regarding assessment and treatment is designed to be a cursory introduction to the topics. The information is not intended to be a substitute for professional medical advice, diagnosis, or treatment nor comprehensive training under a veterinary professional. The authors are not responsible or liable for any advice, course of treatment, diagnosis, or service. CBEMS providers and leaders should review their state's laws before providing medical care to a dog, consult with their medical director, and have the name and number for contact veterinarian(s) available. For additional considerations regarding the legalities of first responders treating working dogs please see: "Best Practice Recommendations for Prehospital Veterinary Care of Dogs and Cats."⁸

Recommendations for on-campus mass gathering event planning

CBEMS leaders involved in planning for on-campus mass gathering events should communicate with local law enforcement to determine if LEK9s might be present at the event. In the possibility of LEK9 presence, CBEMS leaders should determine applicable laws regarding non-veterinary medical treatment of LEK9s and consider developing a pre-event training similar to that described in this report. In addition, CBEMS leaders should consider coordinating before the event with event managers and public safety personnel to develop plans/policies regarding the need to staff veterinary teams and veterinary hospital transport options.

The type of training described in this report can be adapted by other CBEMS organizations in coordination with local veterinarians who are ideally specialists in emergency and critical care. The venue for the training should allow for projection of a presentation on a screen and should have sufficient room for a large group to work together for hands-on skills practice. A dog CPR manikin can be purchased online by the CBEMS organization with the typical cost ranging from \$300 to \$1500. Additional funds for a face mask (approximately \$30) and bag-valve mask (Ambu bag[®]; Ambu Emergency Medical, Columbia, MD) (approximately \$30) should be included in the budget. Otherwise, the cost for a comparable training is low.

The following considerations are important for collegiate EMS providers to be aware of regarding LEK9 emergencies and should be included in pre-event training on LEK9 emergencies; additional details are available in the referenced materials.

Dog handling and identification of emergencies in LEK9s

All volunteers reported that they had no previous experience handling any dogs in a medical capacity but were willing to learn. The identification and treatment of medical emergencies in LEK9s are often the responsibility of the handler. The handler will know his or her dog well, and together with medical providers, both parties can initiate treatment in the case of an emergency in the field. If medical intervention is needed, the handler and EMS can work together un-

Table 2. Basic life support CPR guidelines for canines^{13,14}

- 1. Place a dog on its right side on a hard, flat surface.
- 2. Place your hands, hand over hand, overlying the highest point of the right chest wall, excluding the last 3 ribs.
- 3. Begin chest compressions at a rate equal to 100-120 beats per minute.
- Place a face mask over the snout of the dog and administer a single artificial breath every 30 compressions using an bag-valve mask (if available).
- 5. Cycle every 2 minutes. Consider rotating chest compressors every 2 minutes if there are more than 2 people at the scene to maintain efficacy of compressions. Feel for a femoral pulse to determine if chest compressions should continue.
- 6. Repeat 2 minute cycle during transport. Continue for 15-20 minutes.

til veterinarian-directed care is available⁸ Basic triage and assessment – including the recording of vital signs – can be performed by the medical personnel during initial evaluation of the LEK9 in the field. It is important to note that an injured, conscious working dog may pose a serious health and safety risk to personnel working around them. Appropriate judgment must be used in determining whether a basket muzzle should be placed on the dog prior to treatment or transport, as heat-related illness or respiratory distress could be exacerbated by muzzle placement. It is also important to note that the treatment of a human always supersedes treatment of a canine in situations where both human(s) and canine(s) require immediate medical care.

Blast injuries

Due to the Boston Marathon bombing, blast injury from an explosion is now recognized as a threat to all attendees, including LEK9s, at a marathon or other MGE. Primary injury – due to blast waves – may lead to blunt trauma to the thorax and/or abdomen. Secondary injury – due to flying debris – may lead to penetrating wounds. Tertiary injury – due to an LEK9's being thrown from the blast – may result in both blunt and penetrating trauma. Quaternary injury – all other injuries – may include crush injuries, burns, asphyxia, or toxic exposure.⁸ Blast injuries can involve multiple parts of the body simultaneously; however, in dogs, thoracic injury is generally the most common injury associated with blunt trauma.¹⁵ Due to the nature of blast injuries, many injuries, including thoracic injuries, require advanced-level care. Nonetheless, LEK9s who have been injured in an explosion would benefit from immediate intervention by non-veterinary EMS personnel in the field.

EMS providers can assess vital signs and implement bleeding control measures for external hemorrhage. If external hemorrhage of a limb is identified on an LEK9, EMS providers may first apply firm, direct pressure using a towel, bandage material, or hemostatic compound.⁸ Hemostatic compounds have the same mechanism of action in a canine as a human and can be used to manage hemorrhage if readily available.¹⁶ A tourniquet may be considered; however, one that is made for a human may be too large for a dog limb. In addition, it is not recommended to remove any penetrating objects or debris from the wound site.⁸

Opioid exposure

LEK9s may seek out individuals carrying illicit substances, includ-

ing opioids, that are concealed to the public.¹⁷ Given the high rate of opioid misuse and abuse amongst young adults – estimated at 7.3% of all adults ages 18-25 in the United States in 2016¹⁸ – the possibility that an LEK9 may encounter an opioid must be considered, particularly at events on college and university campuses. Information on the identification and treatment of an accidental opioid exposure in an LEK9 should therefore be included in any pre-MGE training course.

Accidental opioid exposure should be suspected if the presence of opioid drugs is suspected (based on the operational environment) and the dog shows signs of opioid exposure: lethargy, ataxia, pupillary constriction, decreased responsiveness, respiratory depression, and collapse.¹⁹ While opioid exposure alone does not warrant the use of naloxone, administration of naloxone should be considered in a dog that develops respiratory depression or respiratory arrest. EMS or dog handlers may have the reversal agent (ie, naloxone) for use in the event of human exposure. Published guidelines for emergency administration of naloxone to an LEK9 in the event of suspected accidental opioid exposure in the field recommend either an intravenous or intraosseous injection at 0.01-0.04 mg/kg²⁰ or an injection intramuscularly at 0.04 mg/kg - 0.16 mg/kg.²¹ Intranasal administration at 2-4 mg per 25 kg in a dog may also be considered, but there are no published studies directly evaluating the efficacy of intranasal naloxone in dogs.¹⁹

Extreme caution should be practiced by any person who may come in contact with the affected LEK9.¹⁹ When approaching the scene of a suspected opioid overdose in an LEK9, providers should wear personal protective equipment (PPE) to prevent contact with potent opioids. Mouth-to-snout ventilation should NOT be attempted in these patients as the human may contact potent opioids leading to a human death. The LEK9 can and should be ventilated with a bag-valve mask (eg, Ambu[®] bag) in situations where respiratory failure is present, as discussed in greater detail below (see Cardiopulmonary Arrest).¹⁹

Heat-Related Illness

Marathons run all year long, and temperatures on race day vary depending on the location and time of year. The potential for high temperatures may prompt medical staff to prepare for heat related-illnesses in humans, as high temperatures are associated with high patient loads^{22,23}; however, medical staff should also be aware of the potential for heat-related illness in LEK9s. Body temperature in a working dog may be higher than a companion dog during regular exercise, potentially reaching a rectal temperature of 42.2°C or 108°F, whereas normal rectal temperature is 37.4-39.7°C or 99.4-103°F.²⁴ Performance in the field and vulnerability to heat-related illnesses can depend not only on environmental ambient temperature, but also on the K9's body condition, the K9's acclimation to environmental heat, working conditions, availability of potable water, hydration status, and the length and number of rest periods the K9 takes while working.²⁵⁻²⁷ Dehydration is a common condition in dogs working long work shifts with limited break time in addition to decreased access to potable water – a combination that lays the groundwork for heat stress or heat stroke in the field.²⁸

Signs of heat-related illness include increased respiratory rate and effort, lethargy, unwillingness to work, decreased responsiveness to commands, vomiting, diarrhea, and collapse.⁸ If signs of heat-related illness are noted, EMS providers should implement cooling measures using a readily available water source, such as a garden hose, while being careful to avoid induction of shivering.^{8,29} Rapidity of implementing cooling measures is correlated with a positive outcome so immediate cooling is indicated if there is any suspicion of overheating.³⁰ Prompt transport to an available veterinary hospital is also warranted in order to decrease the risk of systemic complications.²⁹

Cardiopulmonary Arrest

The conditions described above – blast injury, toxic/opioid exposure, or heat-related illness – can lead to cardiopulmonary arrest (CPA) in an LEK9, as can other known or unknown conditions. As in humans, starting CPR immediately after CPA may lead to return of spontaneous circulation.³¹ To our knowledge, there are no peer-reviewed published recommendations for non-veterinary medical personnel on how to perform basic life support in a dog. However, instructions on positioning of the dog, hand position, depth of compressions, and number of compressions per minute may be translated from veterinary CPR guidelines (Table 2).^{13,14} In addition, the American Red Cross provides basic instructions online for the layperson: https://www.redcross.org/take-a-class/cpr/performing-cpr/pet-cpr.

In cases where an LEK9 arrests in the field, assisted ventilation with a tight-fitting face bag-valve mask would be the most effective way of administering breaths. Proper placement of an oxygen face mask is crucial for effective ventilation in the field as mouth-to-snout method of ventilation is not recommended due to the potential for opioid exposure and risk of canine bites to the human performing the procedure.³²

Limitations

This case report describes a single pilot training session delivered to prepare CBEMS providers for a specific mass gathering event, the 2018 Illinois Marathon. Without modification, this training may not be sufficient to train EMS providers, or other non-veterinary medical staff, to adequately intervene in LEK9 emergencies at other events and in other contexts. Feedback from attendees indicated that the hands-on portion of the training should have been longer. Future trainings should include additional time for hands-on training, potentially supplemented with live animal training and additional instruction on fitting a face mask on a dog. In addition, it may be valuable for participants to watch instructional videos before the training to maximize the amount of time that can be spent with hands-on practice.

Although feedback obtained through the post-training survey has helped guide future training initiatives, limitations must be acknowledged, including: a low response rate and small number of respondents (perhaps due to a lack of incentives for survey completion), a lack of demographic data (age, sex) obtained, and limited information on the survey's validity and reliability as the survey questions were not piloted prior to distribution. There is a need to further test the efficacy of the training through rigorous assessments of skills and knowledge of attendees.

Conclusions

Due to recent security concerns at marathons and other MGEs, LEK9s may serve on security teams at MGEs. Although the legality of non-veterinary medical personnel treatment of LEK9s varies from state to state, CBEMS providers in select states may be able to provide emergency care to acutely injured or ill LEK9s. CBEMS providers may benefit from comparable training to that described in this report, which focused on the identification and treatment of potential medical emergencies that might occur in LEK9s. CBEMS leaders may consider adapting this training for their organization in consultation with veterinary professionals.

References

- Gates JD, Arabian S, Biddinger P, et al. The Initial Response to the Boston Marathon Bombing: Lessons Learned to Prepare for the Next Disaster. Ann Surg. 2014;260(6):960-966. https://doi.org/10.1097/ SLA.000000000000914
- 2. Milsten AM, Maguire BJ, Bissell RA, Seaman KG. Mass-gathering medical care: a review of the literature. *Prehosp Disaster Med.* 2002;17(3):151–162. https://doi.org/10.1017/S1049023X00000388
- Chapman SG. Police Dogs in North America, 1st Ed. Springfield, IL: Charles C Thomas Publishers;1990:27.
- Pineda GV, Hutson HR, Anglin D, Flynn CJ, Russell MA. Managing Law Enforcement (K–9) Dog Bites in the Emergency Department. Acad Emerg Med. 1996;3(4):352-368. https://doi.org/10.1111/j.1553-2712.1996. tb03449.x
- Hutson HR, Anglin D, Pineda GV, Flynn CJ, Russell MA, McKeith JJ. Law Enforcement K9 Dog Bites: Injuries, Complications, and Trends. Ann Emerg Med. 1997;29(5):637-642. https://doi.org/10.1016/S0196-0644(97)70253-1
- Rebmann A, David E, Sorg MH. Cadaver Dog Handbook: Forensic Training and Tactics for Recovery of Human Remains. Boca Raton, FL: CRC Press Inc; 2000.
- Connors E. Office of Community Oriented Policing Services, U.S. Department of Justice. Planning and Managing Security for Special Events: Guidelines for Law Enforcement. Alexandria, VA: Institute for Law and Justice; 2007.
- Hanel RM, Palmer L, Baker J, et al. Best practice recommendations for prehospital veterinary care of dogs and cats. *J Vet Emerg Crit Care*. 2016;26(2):166-233. https://doi.org/10.1111/vec.12455
- 9. Ranse J , Hutton A , Keene T, et al. Health Service Impact from Mass Gatherings: A Systematic Literature Review. *Prehosp Disaster Med.*

2017;32(1):71-77. https://doi.org/10.1017/S1049023X16001199

- Friedman NMG, O'Connor EK, Munro T, Goroff D. Mass gathering medical care provided by a collegiate-based first response service at an annual college music festival and campus-wide celebration [published ahead of print December 26, 2018]. *Prehosp Disaster Med.* https://doi.org/10.1017/ S1049023X18001103
- Luchette KR, Isik OG, Rybasack-Smith H, Asselin N, Martin TJ, Optimizing collegiate EMS resources during major events. *J Coll Emerg Med Serv.* 2018;1(Suppl 1):S39. https://doi.org/10.30542/JCEMS.2018.01.S1.09
- Ordway EC, Sarna N, DeGeorge LM, Baird AM, Reid MJ, Nable JV. EMS resource utilization at college campus mass gathering events. *J Coll Emerg Med Serv.* 2018;1(2):24-30. https://doi.org/10.30542/JCEMS.2018.01.02.05
- Fletcher DJ, Boller M, Brainard BM, et al. RECOVER evidence and knowledge gap analysis on veterinary CPR. Part 7: Clinical guidelines. *J Vet Emerg Crit Care.* 2012;22(Suppl 1):S102-S131. https://doi.org/10.1111/ j.1476-4431.2012.00757.x
- Hopper K, Epstein SE, Fletcher DJ, et al. RECOVER basic life support domain worksheet authors RECOVER evidence and knowledge gap analysis on veterinary CPR. Part 3: Basic life support. *J Vet Emerg Crit Care.* 2012;22(Suppl 1):S26-S43. https://doi.org/10.1111/j.1476-4431.2012.00753.x
- Simpson SA, Syring R, Otto CM. Severe blunt trauma in dogs: 235 cases (1997-2003). J Vet Emerg Crit Care. 2009;19(6):588-602. https://doi. org/10.1111/j.1476-4431.2009.00468.x
- Palmer LE. Clinical update: Concepts of prehospital traumatic hemorrhage control in the operational K9. *J Spec Op Med.* 2018;18(4):123-130. https:// www.jsomonline.org/JournalArticles/20184.php#Article861. Accessed February 10, 2019.
- Llera RM, Volmer PA. Toxicologic hazards for police dogs involved in drug detection. J Amer Vet Med Assoc 2006;228(7):1028-1032. https://doi. org/10.2460/javma.228.7.1028
- 18. Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration. Key Substance Use and Mental Health Indicators in the United States: Results from the 2016 National Survey on Drug Use and Health.. https://www.samhsa.gov/data/report/key-substanceuse-and-mental-health-indicators-united-states-results-2016-national-survey. Published September 2017. Accessed February 10, 2019.
- Palmer L, Gautier A. Clinical update: The risk of opioid toxicity and naloxone use in operational K9s. *J Spec Op Med.* 2017;17(4):86-92. https://www. jsomonline.org/JournalArticles/20174.php#Article747. Accessed February 10, 2019.
- Plumb DC. Veterinary Drug Handbook. 8th Ed. Stockholm, WI: PharmaVet Inc.; 2015.
- Friese KJ, Newbound GC, Tudan C, et al. Naloxone reversal of an overdose of a novel, long-acting transdermal fentanyl solution in laboratory beagles. J Vet Pharmacol Thera 2012;35(Suppl 2):45-51. https://doi.org/10.1111/j.1365-2885.2012.01409.x
- Arbon P, Bridgewater F, Smith C, et al. Mass gathering medicine: a predictive model for patient presentation and transport rates. *Prehosp Disaster Med.* 2001;16(3):150-158. https://doi.org/10.1017/S1049023X00025905
- 23. Hartman N, Williamson A, Sojka B, et al. Predicting resource use at mass gatherings using a simplified stratification scoring model. *Am J Emerg Med* 2009;27(3):337-43. https://doi.org/10.1016/j.ajem.2008.03.042
- Schneider M. Guidelines for deployment of rescue dogs in hot climate zones. Dubai, Saudi Arabia: Commission for Science and Research, International Rescue Dog Organization, 2009.

- Matwichuch CL, Taylor SM, Schmon CL, Kass PH, Shelton GD. Changes in rectal temperature and hematologic, biochemical, blood gas, and acid-base values in healthy Labrador retrievers before and after strenuous exercise. *Am J Vet Res.* 1999:60(1):88-92.
- Steiss J, Ahmad HA, Cooper P, Ledford C. Physiologic responses in healthy Labrador retrievers during field trail training and competition. *J Vet Intern Med.* 2004;18(2):147-151. https://doi.org/10.1111/j.1939-1676.2004. tb00153.x
- Angle CT, Gilette RL. Telemetric measurement of body core temperature in exercising unconditioned Labrador retrievers. *Can J Vet Res.* 2011;75(2):157-159. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3062928/. Accessed February 10, 2019.
- Baker JL, Hollier PJ, Miller L, Lacy WA. Rethinking heat injury in the SOF mulitpurpose canine: a critical review. *J Spec Op Med.* 2012;12(2):8-15. https://www.jsomonline.org/JournalArticles/20122.php#Article285. Accessed February 10, 2019.
- Magazanik A, Epstein Y, Cassin R, et. al. Tap water, an efficient method for cooling heatstroke victims-a model in dogs. *Aviat Space Environs Med.* 1980; 51(9):864-866.
- Syverud SA, Baker WJ, Amsterdam TP, et al. Iced gastric lavage for treatment of heatstroke: efficacy in a canine model. *Ann Emerg Med.* 1985;14(5):424-432. https://doi.org/10.1016/S0196-0644(85)80286-9
- McIntyre RL, Hopper K, Epstein SE. Assessment of cardiopulmonary resuscitation in 121 dogs and 30 cats at a university teaching hospital (2009-2012). J Vet Emerg Crit Care. 2014;24(6):693-704. https://doi.org/10.1111/ vec.12250
- Briganti A, Melanie P, Portela D, et al. Continuous positive airway pressure administered via face mask in tranquilized dogs. *J Vet Emerg Crit Care*. 2010;20(5):503-508. https://doi.org/10.1111/j.1476-4431.2010.00579.x

Author Affiliations: From Department of Veterinary Clinical Medicine, University of Illinois College of Veterinary Medicine, Urbana, IL, USA (C.T., M.M.); Carle Illinois College of Medicine, Champaign, IL, USA (M.M.); Public Engagement Office, University of Illinois College of Veterinary Medicine, Urbana, IL, USA (A.M.); Carle Regional Emergency Medical Services, Carle Foundation Hospital, Urbana, IL, USA (W.W.); Health Information Management, Carle Foundation Hospital, Urbana, IL, USA (W.W.); Health Alliance, Carle Foundation Hospital, Urbana, IL, USA (M.S.); Illini Emergency Medical Services, Illinois Fire Service Institute, University of Illinois-Urbana/ Champaign, Urbana, IL, USA (N.C.).

Address for Correspondence: Dr. Caroline Tonozzi, DVM, DACVECC, Department of Clinical Veterinary Medicine, University of Illinois College of Veterinary Medicine, 1008 W. Hazelwood Drive, Urbana, IL 61801, USA. Email: tonozzi@illinois.edu

Conflicts of Interest/Funding Sources: By the JCEMS Submission Declaration Form, all authors are required to disclose all potential conflicts of interest and funding sources. All authors declared that they have no conflicts of interest. All authors declared that they did not receive funding to conduct the research and/or writing associated with this work.

Authorship Criteria: By the JCEMS Submission Declaration Form, all authors are required to attest to meeting the four ICMJE.org authorship criteria: (1) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND (2) Drafting the work or revising it critically for important intellectual content; AND (3) Final approval of the version to be published; AND (4) Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Submission History: Received November 5, 2018; accepted for publication February 10, 2019.

Published Online: February 21, 2019.

Published in Print: February 22, 2019 (Volume 2: Issue 1)

Reviewer Information: In accordance with JCEMS editorial policy, Case Reports undergo double-blind peer-review by at least two independent reviewers. JCEMS thanks the anonymous reviewers who contributed to the review of this work. **Copyright:** © 2019 Tonozzi, McMichael, Mitek, Weir, Smith, & Cornwell. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International (CC BY 4.0) License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. The full license is available at: https://creativecommons.org/licenses/by/4.0/

Electronic Link: https://doi.org/10.30542/JCEMS.2019.02.01.03



Submit to JCEMS: the official **scholarly, peer-reviewed journal** of the National Collegiate EMS Foundation.

Original submissions welcome on collegiate EMS:

- Prehospital patient care
- Operations, communications, and equipment
- Training and education
- Leadership
- Administration and agency development
- Career and alumni resources
- Campus public health and safety

Original research is prioritized. Case reports, reviews, and articles featuring perspectives and commentary are also invited.

Research Mentorship

We are committed to mentoring researchers and authors. If you might be interested in conducting a study or submitting a manuscript for publication, consider applying to the JCEMS Research Mentorship Program. Additional details are available at CollegeEMS.com.

Important Information (Volume 2, Issue 2)

Deadline May 1st, 2019

Send submissions to: JCEMS@CollegeEMS.com



The Journal of COLLEGIATE EMERGENCY MEDICAL SERVICES

JOIN THE JCEMS TEAM

Now seeking motivated, passionate volunteers to join the JCEMS team. Available positions in the design, editing, outreach, and business management departments:

- Journalism & Publishing
- Print & Web Design
- Peer Review & Copy-Editing
- Public Relations & Social Media
- Advertising & Marketing

Excellent opportunity for current students and young alumni to gain professional experience in an innovative, scholarly publication.

For current opportunities, please email:

JCEMS@CollegeEMS.com



Please visit **CollegeEMS.com** for more information about JCEMS.

National Collegiate Emergency Medical Services Foundation 26th Annual Conference February 22-24, 2019 Pittsburgh, PA

Leadership

Clinical Excellence

Original Research

