Appendix A Presentation of Results

| Study Characteristics | Publication year | Research Time Span | Originating Institution | Country | Purpose/Aim of the Research | Population | | Setting | | Sample Size | Type of Study | Main Outcomes | How the Study outcome addresses the research Question? (Adams et al., 2021) | Context of civilian and military austere/remote environments (Holcomb, 2018) | Management of non-compressible torso hemorrhage | Healthcare disciplines involved |
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| | | | | | | Age | Sex | Civilian | Military | | | | | | | |
| **Citations** | | | | | | | | | | | | | | | | |
| **Non-compressible Torso Hemorrhage** | | | | | | | | | | | | | | | | |
| Alarhayem, A. Q., Myers, J. G., Dent, D., Liao, L., Muir, M., Mueller, D., . . . Eastridge, B. J. (2016). Time is the enemy: Mortality in trauma patients with hemorrhage from torso injury occurs long before the "golden hour". *The American Journal of Surgery, 212*, 1101-110 | 2016 | 2012 - 2014 | University of Texas Health Science Center at San Antonio, Department of Surgery, Division of Trauma, Critical Care, and Acute Care Surgery, United States<br><br>University of Washington, Department of Surgery, Division of Trauma and Acute Care Surgery, United States | USA | "The purpose of this study was to examine the mortality outcome association between prehospital time and torso injury severity." | Mean 37.4 | Male 67.6% | | Military | 2,523,394 | Retrospective | High-grade torso injuries AIS greater than or equal to 4, degree of anatomic distribution is associated with significant hemorrhage. There was an increase in mortality in patient with prehospital times of less than 30 minutes. Future therapies should be developed to increase the survival window in the prehospital environment. | This article addresses RQ #1, discussing the effectiveness of current innovation in the management of NCTH. Additionally, RQ #2, this article addresses the current knowledge gap in the prehospital management of NCTH. | Addresses prehospital transport times as an independent variable in the management of NCTH in the prehospital realm | Transport time as variable in the management of NCTH | Prehospital providers |
| Chang, R., Fox, E. E., Greene, T. J., Eastridge, B. J., Gilani, R., Chung, K. K., DeSantis, S. M., DuBose, J. J., Tomasek, J. S., Fortuna, G. R., Jr, Sams, V. G., Todd, S. R., Podbielski, J. M., Wade, C. E., Holcomb, J. B., & NCTH Study Group (2017). Multicenter retrospective study of noncompressible torso hemorrhage: Anatomic locations of bleeding and comparison of endovascular versus open approach. *The journal of trauma and acute care surgery*, *83*(1), 11–18. https://doi.org/10.1097/TA.0000000000001530 | 2017 | 2008 - 2012 | The University of Texas Health Science Center at Houston (UTHealth)<br><br>Baylor College of Medicine<br><br>the University of Texas Health Science Center at San Antonio<br><br>The San Antonio Military Medical Center<br><br>The Human Research Protections Office of the US Army Medical Research and Materiel Command. | USA | "The objective of this study was two-fold: first, to describe the precise anatomic locations of bleeding in a population of adult trauma patients with NCTH, and second, to test the hypothesis that the endovascular (ENDO) versus open (OPEN) approach was associated with reduced mortality in trauma patients presenting with NCTH." | 31-38 | Male 76-83% | Civilian | Military | 543 | Retrospective Study | Endoscopic intervention in the management of NCTH in civilian trauma centers was associated with overall decrease in mortality in comparison to Open procedures and Resuscitative Thoracotomy | Endoscopic interventions in the management of NCTH address the first research question concerning current innovation in the management of NCTH in civilian institutions. | Addresses three intrahospital interventions to control hemorrhage in patients with NCTH at four ACS level one trauma centers in the USA. | Controlling hemorrhage in patients with NCTH in level one trauma centers | Trauma Surgeon<br>Vascular Surgeon |
| Duchesne, J., Slaughter, K., Puente, I., Berne, J. D., Yorkgitis, B., Mull, J., Sperry, J., Tessmer, M., Costantini, T., Berndtson, A. E., Kai, T., Rokvic, G., Norwood, S., Meadows, K., Chang, G., Lemon, B. M., Jacome, T., Van Sant, L., Paul, J., Maher, Z., … Tatum, D. (2022). Impact of time to surgery on mortality in hypotensive patients with noncompressible torso hemorrhage: An AAST multicenter, prospective study. *The journal of trauma and acute care surgery*, *92*(5), 801–811. https://doi.org/10.1097/TA.0000000000003544 | 2022 | 2018-2020 | New Orleans, Louisiana; Broward Health Medical Center Fort Lauderdale; University of Florida-Jacksonville Jacksonville, Florida<br><br>University of Pittsburgh Pittsburgh, Pennsylvania<br><br>UC San Diego Medical Center San Diego, California | USA | "We hypothesized that shorter times to surgical intervention for hemorrhage control would decrease mortality in hypotensive patients with NCTH." | Mean 40.5 | Male 74.8% | Civilian | | 242 | Multicenter, prospective, observation study | The current concept for managing NCTH in the US is flawed. A new concept of hemorrhage control and blood product resuscitation should be moved closer to the point of injury as part of Advanced Resuscitative care while maintaining rapid transport | The current knowledge gap for the management of NCTH is where and when is the ideal time and place intervention to manage NCTH to decrease mortality. | Addresses the theory that mortality can be decreased in patients with NCTH with improved prehospital care and shorter in-hospital times to control. | Prehospital Advanced Resuscitative care should be initiated as close to the point of injury as possible. | -Prehospital Providers<br>-Emergency Medicine Providers<br>-Trauma Surgeons |

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| | | | University of Kentucky Chandler Medical Center Lexington, Kentucky<br><br>University of Texas Health Tyler Tyler, Texas<br><br>Mount Sinai Hospital Chicago, Illinois<br><br>Our Lady of the Lake Regional Medical Center Baton Rouge, Louisiana<br><br>University of New Mexico Hospital Albuquerque, New Mexico<br><br>Temple University Hospital Philadelphia, Pennsylvania<br><br>St. Anthony Hospital Lakewood, Colorado<br><br>Research Medical Center Kansas City, Missouri<br><br>Ascension Via Christi Hospital St. Francis Wichita, Kansas<br><br>Medical City Plano, Plano, Texas. | | | | | | | | | to a surgical treatment facility. | | | | |
| Geeraedts, Kaasjager, H. A. ., van Vugt, A. ., & Frölke, J. P. . (2009). Exsanguination in trauma: A review of diagnostics and treatment options. *Injury*, *40*(1), 11–20. https://doi.org/10.1016/j.injury.2008.10.007 | 2009 | | Radboud University Nijmegen Medical Centre | Netherlands | | | | Civilian | | | Review | Early hemorrhage control, resuscitation and coagulation management has the potential to improve survival in patient with exsanguination trauma. Prehospital providers intervening closer to the point of injury utilizing Advanced Resuscitative Care may be the course forward in decreasing mortality. | Addresses the knowledge gaps in current literature regarding the best intervention in exsanguination trauma in Prehospital care. | Addresses the concept of current hemorrhage control, resuscitation, and coagulation management in the prehospital management of exsanguination trauma and theorizes potential innovations for future care. | Development of a prehospital protocol led approach to early intervention in the management of exsanguination trauma. | -Prehospital provider<br>-Trauma Surgeon<br>-Politicians |
| Harvin, J. A., Maxim, T., Inaba, K., Martinez-Aguilar, M. A., King, D. R., Choudhry, A. J., Zielinski, M. D., Akinyeye, S., Todd, S. R., Griffin, R. L., Kerby, J. D., Bailey, J. A., Livingston, D. H., Cunningham, K., Stein, D. M., Cattin, L., Bulger, E. M., Wilson, A., Undurraga Perl, V. J., Schreiber, M. A., … Holcomb, J. B. (2017). Mortality after emergent trauma laparotomy: A multicenter, retrospective study. *The journal of trauma and acute care surgery*, *83*(3), 464–468. https://doi.org/10.1097/TA.0000000000001619 | 2017 | 2012-2013 | University of Texas McGovern Medical School at Houston<br><br>University of Southern California Keck School of Medicine<br><br>Harvard Medical School (Boston, Massachusetts),<br><br>Mayo | USA | "The purpose of this study was to determine the current mortality rate and cause of death for hypotensive trauma patients undergoing emergent laparotomy. We hypothesize that mortality rates in this group would have decreased | Median 31 years IQR (24, 45) | Male 84% | Civilian | | 1706 | Multicenter, Retrospective Study | There has been change in mortality of patients undergoing hypotensive trauma laparotomy over the last twenty years | Address the current and past innovations in patients undergoing emergent trauma laparotomy | Addresses time spent in the Emergency Department followed by time in the operating room overall effects on mortality. | Intrahospital management of hypotensive patients requiring Emergent Trauma Laparotomy | -Trauma Surgeons<br>-Emergency Medicine Providers |

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| | | | Clinic (Rochester, Minnesota)<br><br>Baylor College of Medicine (Houston, Texas)<br><br>University of Alabama School of Medicine (Birmingham, Alabama)<br><br>Rutgers New Jersey Medical School (Newark, New Jersey)<br><br>University of Maryland School Of Medicine (Baltimore, Maryland)<br><br>University of Washington, Harborview Medical Center (Seattle, Washington)<br><br>West Virginia University School of Medicine (Morgantown, West Virginia)<br><br>Oregon Health & Science University (Portland, Oregon)<br><br>University of Michigan Medical School (Ann Arbor, Michigan). | | over the interim years." | | | | | | | | | | | |
| Kelly, J. F., Ritenour, A. E., McLaughlin, D. F., Bagg, K. A., Apodaca, A. N., Mallak, C. T., Pearse, L., Lawnick, M. M., Champion, H. R., Wade, C. E., & Holcomb, J. B. (2008). Injury severity and causes of death from Operation Iraqi Freedom and Operation Enduring Freedom: 2003-2004 versus 2006. *The Journal of trauma*, *64*(2 Suppl), S21–S27. https://doi.org/10.1097/TA.0b013e318160b9fb | 2008 | -2003-2004<br><br>-June 2006-December 2006 | United States Army Institute of Surgical Research | USA | "Our hypothesis was that as the use of IEDs has increased and injuries were more severe causing increased clinical challenges for patient care." | Mean<br><br>Group 1<br>26+/- 6.8<br><br>Group 2<br>25+/-6.4 | Group 1<br>Male<br>98%<br><br>Group 2<br>Male<br>99% | | Military | 982 | In-depth review similar to a surgical morbidity and mortality conference | There is no comparing civilian and military trauma. In civilian trauma 84 to 90% of deaths are from blunt trauma, and 83% of deaths in the military are from penetrating trauma. Hemorrhage is the leading cause of death in both military and civilian trauma, truncal hemorrhage being the leading cause in civilian and military deaths. | The lack of current innovations in the improvement of mortality in the management of NCTH in civilian and military trauma. | Addresses potential prehospital management to improve mortality in the management of NCTH in civilian and military trauma | Providing prehospital providers with resource for damage control resuscitation vs advanced resuscitative care. | Prehospital provider |
| Kobayashi L, Coimbra R, Goes AMO Jr, Reva V, Santorelli J, Moore EE, Galante JM, Abu-Zidan F, Peitzman AB, Ordonez CA, Maier RV, Di Saverio S, Ivatury R, De Angelis N, Scalea T, Catena F, Kirkpatrick A, Khokha V, Parry N, Civil I, Leppaniemi A, Chirica M, Pikoulis E, Fraga GP, Chiarugi M, Damaskos D, Cicuttin E, Ceresoli M, De Simone B, Vega-Rivera F, Sartelli M, Biffl W, Ansaloni L, Weber DG, Coccolini F. American Association for the Surgery of Trauma-World Society of Emergency Surgery guidelines on diagnosis and management of abdominal vascular injuries. J Trauma Acute Care Surg. 2020 Dec;89(6):1197-1211. doi: | 2020 | 2007 – 2020 | Division of Trauma Surgical Critical Care, Burns, and Acute Care Surgery, University of California San Diego, San Diego | USA | "Through an extensive review of the available evidence, we seek to summarize the literature to date and provide updated, evidence-based recommendations for the diagnosis and management of abdominal vascular injuries." | | | Civilian | Military | | Review of the Literature | Abdominal vascular injuries is a significant contributor to morbidity and mortality in trauma. Major abdominal vascular injury is a leading cause of NCTH (40%). Only 4 to 12% of | Addresses effectiveness of current innovations associated management of abdominal vascular trauma in civilian and military environments. | Addresses potential usage of REBOA in the emergency department/trauma bay and endovascular intervention in operative environment. | Intrahospital management of vascular trauma in emergency department and operating. | -Emergency Medicine providers<br>-Trauma Surgeons<br>-Vascular Surgeons<br>-Interventional Radiologist |

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| 10.1097/TA.0000000000002968. PMID: 33230049. | | | | | | | | | | | | military trauma is vascular trauma. DCS and DCR should be used liberally and may improve outcomes. | | | | |
| Magyar, C., Bednarski, P., Jakob, D. A., Schnüriger, B., & "Swiss Trauma Registry" (2021). Severe penetrating trauma in Switzerland: first analysis of the Swiss Trauma Registry (STR). *European journal of trauma and emergency surgery : official publication of the European Trauma Society*, 10.1007/s00068-021-01822-w. Advance online publication. https://doi.org/10.1007/s00068-021-01822-w | 2021 | 2017-2019 | Department of Visceral Surgery and Medicine, Inselspital, Bern University Hospital, University of Bern, | Switzerland | "We hypothesize, that (1) the number of patients suffering from severe penetrating trauma in Switzerland is low and (2) the patient demographics and injury characteristics are different in international comparison. Primary outcome was mortality; secondary outcomes were hospital and intensive care unit (ICU), length of stay and prehospital times." | Median<br>34<br><br>(IQR)<br>27.0-48.0 | Male<br>79.1% | Civilian | | Total in study<br>8261<br><br>Participants with torso trauma<br>67 | Retrospective multicenter cohort study | Severe penetrating trauma in Switzerland remains low and due to the lack of sustainment this presents a challenge to prehospital and hospital providers. Regular sustainment training is essential to decreasing mortality in penetrating trauma to the torso and decrease in prehospital transport times may be essential in decreasing mortality. | Maintenance of current innovation in the management of prehospital and hospital penetrating trauma may be essential in decreasing mortality in penetrating trauma. | Addresses the prehospital transport times and in hospital management of patient with penetrating torso trauma. | Regular and frequent Sustainment training in the management of penetrating torso trauma and assessing transport times from point of injury to definitive surgical care. | -Prehospital providers<br>-Emergency Medicine providers<br>-Trauma Surgeons |
| Morrison, J. J., Stannard, A., Rasmussen, T. E., Jansen, J. O., Tai, N. R., & Midwinter, M. J. (2013). Injury pattern and mortality of noncompressible torso hemorrhage in UK combat casualties. *The journal of trauma and acute care surgery*, *75*(2 Suppl 2), S263–S268. | 2013 | 2002-2012 | Academic Department of Military Surgery and Trauma Royal Centre for Defense Medicine, Birmingham<br><br>Academic Unit of Surgery Glasgow Royal Infirmary, Glasgow<br><br>16 Medical Regiment United Kingdom<br><br>US Army Institute of Surgical Research Fort Sam Houston<br><br>59th Medical Deployment Wing Science and Technology Section, Lackland Air Force Base, San Antonio, Texas<br><br>The Norman M. Rich Department of Surgery the Uniformed Services University of the Health Sciences, Bethesda, Maryland. | United Kingdom | The aim of this study was to examine a complete population of patients with NCTH, injured in wartime, to characterize the injury pattern before and after MTF admission. | <u>Survivors</u><br>Median<br>23<br>(IQR)<br>8<br><br><u>Nonsurvivors</u><br>Died of wounds<br><br>Median<br>23<br>(IQR)<br>8<br><br>Killed in Action<br><br>Median<br>26<br>(IQR)<br>9 | <u>Survivors</u><br>Male<br>43(100%)<br><br><u>Nonsurvivors</u><br>Died of wounds<br><br>Male<br>31(100%)<br><br>Killed in Action<br><br>Male<br>218 (98.2%) | | Military | 296 | Retrospective | 90% of patient with NCTH die in the prehospital phase of care. Major arterial, pulmonary hilar and liver injury are independent predictors of mortality in patient with NCTH. Prehospital hemorrhage control and resuscitation are essential in the management of prehospital NCTH to reduce mortality in the prehospital environment. | Discusses current gaps in the management of NCTH existing within the Prehospital hemorrhage control and resuscitation phases of care. | Addresses the Prehospital and intra-hospital mortality associated with NCTH and theorizes the potential impact of Prehospital hemorrhage control and resuscitation. | Addresses the Prehospital, emergency room and time in the operating room effects on mortality in patients with NCTH. | -Prehospital providers<br>-Emergency Medicine providers<br>-Trauma Surgeons |
| Pannell, D., Brisebois, R., Talbot, M., Trottier, V., Clement, J., Garraway, N., McAlister, V., & Tien, H. C. (2011). Causes of death in Canadian Forces members deployed to Afghanistan and implications on tactical combat casualty care provision. *The Journal of trauma*, *71*(5 Suppl 1), S401–S407. https://doi.org/10.1097/TA.0b013e318232e53f | 2011 | 2006-2008 | 2 Field Ambulance Canadian Forces Base Petawawa, Petawawa, Ontario, Canada<br><br>General Surgery and the Trauma Program Sunny- brook Health Sciences Centre, | Canadian | We aimed to identify fatal injuries where better provision of TCCC interventions might have improved outcome. Another focus was to | Mean<br>29 (+/- 7) | Male<br>98% | | Military | 73 | Retrospective autopsy reports | Major cause of death to Canadian conventional forces were blast injuries for IED with exsanguination and neurologic injury as major | Current TCCC innovations do not address the dynamic injury patterns as seen on today modern battlefield and will need to be addressed | Addresses the prehospital management of patients due to blast injuries with associated exsanguination. TCCC does not address or have solutions to | Addresses care at the point of injury and touches on transport times to emergency and surgical care | -Prehospital Providers |

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| | | | Toronto, Ontario, Canada<br><br>Department of National Defense 1 Canadian Field Hospital, Canadian Forces Base Petawawa, Ontario, Canada. | | identify fatal injuries that might be survivable with simple interventions not currently included in TCCC. | | | | | | | contributors to mortality during the prehospital phase. Current TCCC guidelines do not address all aspects of care in a dynamic combat environment and will need to be addressed for future engagements to decrease mortality. | before future conflicts. Prehospital providers will need additional resources to support and or sustain life in future engagements. | management of some of the dynamic injuries as noted on today's battlefield. | | |
| Patel, S., Rasmussen, T. E., Gifford, S. M., Apodaca, A. N., Eastridge, B. J., & Blackbourne, L. H. (2012). Interpreting comparative died of wounds rates as a quality benchmark of combat casualty care. *The journal of trauma and acute care surgery*, *73*(2 Suppl 1), S60–S63. https://doi.org/10.1097/TA.0b013e31826061b4 | 2012 | 2004-2008 | US Army Institute for Surgical Research, Brooke Army Medical Center,<br>Fort Sam Houston, Texas. | USA | This study aimed to use the DOW rates calculated by the Department of Defense and determine if, within the high and low DOW months, there are discernible differences in wounding patterns and body regions injured, severity of body-region in- jury and Injury Severity Scores (ISSs), and mechanism of injury. | LDOW<br>Mean<br><br>26.3<br><br>HDOW<br>Mean<br><br>26.0 | LDOW<br>Male<br><br>98.9%<br><br>HDOW<br>Male<br><br>98.2% | | Military | 890 | Retrospective | Comparative evaluation of died of wounds (DOW) in combat theaters is still variable. What is not variable is that NCTH is a leading cause of death on the battlefield. | Addresses the discussion that NCTH remains a leading cause of public health mortality in trauma. | Addresses despite the definition NCTH remains a leading cause of death on the battlefield | N/A | -Prehospital Providers<br>-Emergency Medicine Providers<br>-Trauma Surgeons |
| Schrager, J. J., Branson, R. D., & Johannigman, J. A. (2012). Lessons from the tip of the spear: medical advancements from Iraq and Afghanistan. *Respiratory care*, *57*(8), 1305–1313. https://doi.org/10.4187/respcare.01881 | 2012 | | Division of Trauma/Critical Care, Department of Surgery, University of Cincinnati, Cincinnati, Ohio. | USA | Lecture | | | | Military | | Lecture | Current innovations in the management of Combat casualties has evolved to meet the current austere combat environments that our troops see themselves in today. This continued evolution has decreased mortality and future research will continue to evolve combat casualty care | Addresses the current innovation, knowledge gaps and future innovations of combat casualty care and the management of NCTH in austere environments. | Addresses prehospital, emergency medicine and trauma care in austere environments | Addresses current and future innovations in austere trauma management. | -Prehospital Providers<br>-Emergency medicine providers<br>-Trauma Surgeons |
| Stannard, A., Morrison, J. J., Scott, D. J., Ivatury, R. A., Ross, J. D., & Rasmussen, T. E. (2013). The epidemiology of noncompressible torso hemorrhage in the wars in Iraq and Afghanistan. *The journal of trauma and acute care surgery*, *74*(3), 830–834. https://doi.org/10.1097/TA.0b013e31827a3704 | 2013 | 2002-2010 | Academic Department of Military Surgery and Trauma<br>Royal Centre for Defense Medicine, Birmingham, United Kingdom<br><br>US Army Institute of Surgical Research Fort Sam Houston<br><br>59th Medical Deployment Wing Science and Technology Section, Lackland Air Force Base, San Antonio, Texas | USA | The objective of this study was to characterize the prevalence of NCTH in a large population of wartime casualties using this contemporary definition. In that context, an additional objective was to characterize the mortality of this injury pattern within a population of combat wounded and identify sites of vascular disruption within | Age<br><br>Mean (SD)<br><br>25.8 (6.6) | Male<br><br>97.6% | | Military | 1936 | Retrospective | NCTH was identified as a significant predictor of mortality due to battlefield injury, with a greater predictor of mortality in patients with axial vessel and pulmonary injury. Prehospital hemorrhage control and resuscitation are essential to potentially decrease mortality in | Addresses the effectiveness of current innovations and infers to a potential solution in the Prehospital management of NCTH. | Infers mortality associated with NCTI/NCTH in the prehospital (point of injury to transport), emergency department and operating rooms interventions. | Addresses the mortality of NCTI and NCTH | -Prehospital providers<br>-Emergency Medicine Providers<br>-Trauma Surgeons |

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| | | | The Norman M. Rich Department of Surgery the Uniformed Services University of the Health Sciences, Bethesda, Maryland. | | the torso associated with the highest mortality. | | | | | | | patient with NCTH. | | | | |
| van Oostendorp, S. E., Tan, E. C., & Geeraedts, L. M., Jr (2016). Prehospital control of life-threatening truncal and junctional haemorrhage is the ultimate challenge in optimizing trauma care; a review of treatment options and their applicability in the civilian trauma setting. *Scandinavian journal of trauma, resuscitation and emergency medicine*, *24*(1), 110. https://doi.org/10.1186/s13049-016-0301-9 | 2016 | No restriction to Publication dates | Department of Trauma Surgery, VU University Medical Center, MB Amsterdam | Netherlands | The aim of this review is to provide an overview of modern (experimental) treatment options for control of junctional and truncal haemorrhage in the prehospital arena. Also, since most developments are ensuing from necessities in the battlefield situations, the applicability of the treatment options are discussed in the light of the civilian setting and especially in the context of differences in patient demographics, trauma mechanism and prehospital situations. | | | Civilian | Military | | Review of the Literature | Hemorrhage control from junctional and NCTH remains and high predictor of mortality in the prehospital environments. Civilian and military prehospital providers work in different environment and encounter different mechanisms of injury. Despite the translation of compressible interventions from the military to civilian population. There is no effective intervention for the management of NCTH. | Addresses the effectiveness of current innovations, potential future innovations and potential future gaps in the management of NCTH. | Addresses management at the point of injury in association with prehospital transport to decrease mortality in the management of NCTH. | Addresses Prehospital innovations in the management of NCTH. | -Prehospital providers<br>-Emergency medicine providers |
| Waibel, B. H., & Rotondo, M. F. (2010). Damage control in trauma and abdominal sepsis. *Critical care medicine*, *38*(9 Suppl), S421–S430. https://doi.org/10.1097/CCM.0b013e3181ec5cbe | 2010 | | Department of Surgery, Division of Trauma and Surgical Critical Care, The Brody School of Medicine, East Carolina University, Greenville, NC. | USA | Understanding the principles of operative control of hemorrhage within the abdomen, resuscitation and complications of Damage control surgery. | | | Civilian | Military | | Review of concept | Review of the underlying principles of damage control surgery | Addresses the effectiveness of current innovations in the management of NCTH of the abdomen | Addresses care at the point of injury, transport time, time spent in the emergency room and time spent in the operating room. | Addresses prehospital innovation, emergency medicine innovations and intra-operative innovations | -Prehospital providers<br>-Emergency Medicine Providers<br>-Trauma Surgeons |
| **Penetrating Abdominal Trauma** | | | | | | | | | | | | | | | | |
| Brown, C. V., Velmahos, G. C., Neville, A. L., Rhee, P., Salim, A., Sangthong, B., & Demetriades, D. (2005). Hemodynamically "stable" patients with peritonitis after penetrating abdominal trauma: identifying those who are bleeding. *Archives of surgery (Chicago, Ill. : 1960)*, *140*(8), 767–772. https://doi.org/10.1001/archsurg.140.8.767 | 2005 | January 2003 – December 2004 | Department of Surgery, Division of Trauma and Critical Care, University of Southern California Keck School of Medicine, Los Angeles County/University of Southern California Medical Center, Los Angeles<br><br>Department of Surgery, Division of Trauma, Emergency Surgery, and Critical Care, Harvard Medical School, Massachusetts General Hospital, Boston | USA | Our hypothesis was that despite initial presentation, hemodynamically stable patients with peritonitis following penetrating abdominal trauma may have significant ongoing hemorrhage and catastrophic intra-abdominal injuries requiring emergent surgical intervention. | Mean Age<br><br>29 +/-10 years | Male<br><br>94% | Civilian | | 139 | Prospective, observational study | Hemodynamic stability and penetrating abdominal trauma should not be used in isolation to determine non-operative management of patient with penetrating abdominal trauma. Peritonitis as a result of penetrating abdominal trauma should prompt exploratory laparotomy. | Addresses the current innovations and existing knowledge gaps in the management of NCTH of the abdomen | Addresses the time spent in the prehospital point of injury and transport time, emergency room and time spent in the operating room. | Addresses prehospital, emergency medicine assessment and diagnosis of intra-abdominal bleeding to rapid transport patients to definitive surgical care. | -Prehospital Providers<br>-Emergency Medicine provider<br>-Trauma Surgeons |

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| Johnson, J. W., Gracias, V. H., Schwab, C. W., Reilly, P. M., Kauder, D. R., Shapiro, M. B., Dabrowski, G. P., & Rotondo, M. F. (2001). Evolution in damage control for exsanguinating penetrating abdominal injury. *The Journal of trauma*, *51*(2), 261–271. https://doi.org/10.1097/00005373-200108000-00007 | 2001 | July 1997-May 2000 | *Department of Surgery, Division of Traumatology and Surgical Critical Care University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania,*<br><br>*Department of Surgery, Division of Trauma and Surgical Critical Care Brody School of Medicine, East Carolina University, Greenville, North Carolina.* | USA | In an effort to qualify changes in principles and promote modern understanding of the techniques of DC, we sought to compare a current group of DC patients (the current study [CS]) with those treated a decade earlier (HS). | Current study<br><br>Mean Age 25.6 (9.0)<br><br>Comparison<br><br>Historical Group<br><br>Mean Age 30.6 (9.6) | Current Study<br><br>Male 100%<br><br>Comparison<br><br>Historical Group<br><br>Male 95.8% | Civilian | | Current study<br><br>21 Patients<br><br>Comparison<br><br>Historical Group<br><br>24 Patients | Retrospective | Damage Control Surgery comparison from a decade prior show progressive evolution in patients who present to emergency departments with indications for DCS. Research should focus on implementation of Damage Control Zero should be further studied and implemented to show an evolutionary decrease in mortality in patient with penetrating abdominal trauma. | Addresses the current innovations and existing knowledge gaps in the management of NCTH of the abdomen | Addresses the evolutionary decision making in managing patients with penetrating abdominal trauma in a prehospital, emergency department and operative perspective. | Addresses the evolution of prehospital, emergency medicine assessment and diagnosis of intra-abdominal bleeding and environmental initiation of Damage Control Surgery. | -Prehospital Providers<br>-Emergency Medicine provider<br>-Trauma Surgeons |
| REBOA | | | | | | | | | | | | | | | | |
| Morrison, J. J., Galgon, R. E., Jansen, J. O., Cannon, J. W., Rasmussen, T. E., & Eliason, J. L. (2016). A systematic review of the use of resuscitative endovascular balloon occlusion of the aorta in the management of hemorrhagic shock. *The journal of trauma and acute care surgery*, *80*(2), 324–334. https://doi.org/10.1097/TA.0000000000000913 | 2016 | 1946-2015 | Academic Unit of Surgery Glasgow Royal Infirmary, Glasgow<br><br>Academic Department of Military Surgery and Trauma Royal Centre for Defense Medicine, Birmingham<br><br>Departments of Surgery and Intensive Care Medicine Aberdeen Royal Infirmary and Health Services Research Unit, University of Aberdeen, Aberdeen, United Kingdom<br><br>Department of Anesthesiology University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin<br><br>Division of Traumatology, Surgical Critical Care and Emergency Surgery Perelman School of Medicine at the University of Pennsylvania, Philadelphia, Pennsylvania<br><br>US Combat Casualty Care Research Program Fort Detrick, Frederick<br><br>The Norman M. Rich Department of | United Kingdom | The aim of this systematic review was fourfold: first, to examine the clinical setting and use of REBOA in the prevention of cardiovascular collapse in patients either at risk of or in established hemorrhagic shock; second, to identify common arterial access methods, imaging modalities, and deployment techniques used to facilitate REBOA; third, to report the hemodynamic profile associated with REBOA use in hemorrhagic shock; and finally, to examine the reported mortality and morbidity associated with REBOA as a clinical technique. | | | Civilian | Military | Total Studies<br><br>83<br><br>Met inclusion criteria<br><br>41 | Systematic Review | REBOA is an effective adjunct in raising central blood pressure in patients with hemorrhagic shock. However, evidence is lacking as to its effects on mortality. | Addresses the effectiveness of current innovations in managing NCTH of the abdomen. | Infers effectiveness of hemorrhage control adjuncts for NCTH in prehospital, Emergency room and operating room. | Use of REBOA for hemorrhage control in patient with NCTH | -Prehospital Providers<br>-Emergency Medicine provider<br>-Trauma Surgeons |

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| | | | Surgery The Uniformed Services University of the Health Sciences, Bethesda, Maryland<br><br>The Section of Vascular Surgery University of Michigan, Ann Arbor, Michigan. | | | | | | | | | | | | | |
| Sadeghi, M., Nilsson, K. F., Larzon, T., Pirouzram, A., Toivola, A., Skoog, P., Idoguchi, K., Kon, Y., Ishida, T., Matsumara, Y., Matsumoto, J., Reva, V., Maszkowski, M., Bersztel, A., Caragounis, E., Falkenberg, M., Handolin, L., Kessel, B., Hebron, D., Coccolini, F., … Hörer, T. M. (2018). The use of aortic balloon occlusion in traumatic shock: first report from the ABO trauma registry. *European journal of trauma and emergency surgery: official publication of the European Trauma Society*, *44*(4), 491–501. https://doi.org/10.1007/s00068-017-0813-7 | 2018 | 2011-2016 | Västmanlands Hospital Västerås, Department of Vascular Surgery, Örebro University<br><br>Department of Cardiothoracic and Vascular Surgery, Faculty of Medicine and Health, Örebro University Hospital | -Sweden | The aim of this current study is to present the initial findings of the worldwide Aortic Balloon Occlusion Trauma registry (ABO Trauma Registry) and patient outcomes. | Mean Age<br><br>52+/- 22 years | Male<br><br>68% | Civilian | Military | 96 Total cases | Multicenter-international study-observational report | REBOA is an effective adjunct in raising central blood pressure in patients with hemorrhagic shock. However, evidence is lacking as to its effects on mortality. | Addresses the effectiveness of current innovations of partial REBOA, intermittent REBOA, and REBOA in managing NCTH of the abdomen mortality. | Infers effectiveness of hemorrhage control adjuncts for NCTH in prehospital, Emergency room and operating room and patients' mortality | Use of REBOA for hemorrhage control in patient with NCTH | -Prehospital Providers<br>-Emergency Medicine provider<br>-Trauma Surgeons |
| Biffl, W. L., Fox, C. J., & Moore, E. E. (2015). The role of REBOA in the control of exsanguinating torso hemorrhage. *The journal of trauma and acute care surgery*, *78*(5), 1054–1058. https://doi.org/10.1097/TA.0000000000000609 | 2015 | | Department of Surgery Denver Health Medical Center, Denver, Colorado. | USA | Discussing the use of and algorithm for REBOA in patient exsanguinating from torso hemorrhage. | | | Civilian | Military | | Review | REBOA as a means of hemorrhage control in patient with NCTH. | Addresses the effectiveness of using an algorithm in managing NCTH using a REBOA. | Addresses the usage of an algorithm in the management of NCTH in the prehospital, Emergency room and operating room hemorrhage control and resuscitation of trauma patients. | Addresses the use of an algorithm, to manage patient with NCTH. | -Prehospital Providers<br>-Emergency Medicine provider<br>-Trauma Surgeons |
| García, A. F., Manzano-Nunez, R., Orlas, C. P., Ruiz-Yucuma, J., Londoño, A., Salazar, C., Melendez, J., Sánchez, Á. I., Puyana, J. C., & Ordoñez, C. A. (2021). Association of resuscitative endovascular balloon occlusion of the aorta (REBOA) and mortality in penetrating trauma patients. *European journal of trauma and emergency surgery: official publication of the European Trauma Society*, *47*(6), 1779–1785. https://doi.org/10.1007/s00068-020-01370-9 | 2021 | 2014-2018 | Fundación Valle del Lili University Hospital, Clinical Research Center, Cali, Colombia<br><br>Department of Surgery, Universidad del Valle, Cali Columbia<br><br>School of Medicine, Universidad ICESI, Cali, Colombia<br><br>Clinical Research Center, Fundación Valle del Lili, Cali, Colombia<br><br>Brigham and Women's Hospital, Department of Surgery, Center for Surgery and Public Health, Boston, MA, USA<br><br>Department of Surgery, University of Pittsburg, Pittsburgh, PA, USA | Columbia | The purpose of this study was to examine the association of REBOA and mortality in a group of patients with penetrating trauma to the torso, treated in a level-I trauma center from Colombia. | Median Age<br><br>27 (21-35) | Male<br><br>90.4% | Civilian | | 345 | Retrospective observational study | Reboa provided a survival benefit in patient with penetrating trauma to the torso in comparison to patients not treated with REBOA. | Addresses the effectiveness of current intervention in the management of NCTH and discusses gaps in literature which should be evaluated with prospective studies. | Addresses the usage of REBOA in an Emergency room vs operating room environment and the associated mortality in penetrating trauma to the torso. | Addresses the use of REBOA in managing torso hemorrhage | -Prehospital Providers<br>-Emergency Medicine provider<br>-Trauma Surgeons |
| Gorman, E., Nowak, B., Klein, M., Inaba, K., Morrison, J., Scalea, T., Seamon, M., Fox, C., Moore, L., Kauvar, D., Spalding, M., Dubose, J., DiMaggio, C., Livingston, D. H., Bukur, M., & AAST AORTA Study Group (2021). High resuscitative endovascular balloon occlusion of the aorta procedural volume is associated with improved outcomes: An analysis of the AORTA registry. *The journal of trauma and acute care surgery*, *91*(5), 781–789. https://doi.org/10.1097/TA.0000000000003201 | 2021 | 2014-2018 | Department of Surgery, Rutgers New Jersey Medical School Newark, New Jersey<br><br>NYU Langone Department of Surgery, Division of Acute | USA | Our primary outcome was to compare the mortality rate between high- and low-volume REBOA centers. Our secondary outcome was to compare REBOA-related | Mean Age<br><br>43 +/- 18 | Male<br><br>76% | Civilian | | 495 | Retrospective analysis | The use of REBOA in high utilization institution provides a greater chance of survival when compared to low utilization institution. | Addresses the effectiveness of REBOA in high utilization institutions versus low utilization institution in patients with NCTH | Addresses the time spent in the Emergency room and time spent in the Operating Room with the discussion of low utilization centers potentially have a decreased survival benefit. | Addresses the frequency of usage of REBOA in managing torso hemorrhage | -Emergency Medicine provider<br>-Trauma Surgeons |

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| | | | Care Surgery, Bellevue Hospital Center New York, New York<br><br>Los Angeles County + University of Southern California Hospital Los Angeles, California; Los Angeles County + University of Southern California Medical Center, Division of Trauma/Surgical Critical Care, Los Angeles, California<br><br>R. Adams Cowley Shock Trauma Center/CSTARS (Center for the Sustainment of Trauma and Readiness Skills) University of Maryland, Baltimore, Maryland<br><br>Division of Traumatology, Surgical Critical Care and Emergency Surgery, Perelman School of Medicine, University of Pennsylvania Philadelphia, Pennsylvania<br><br>Memorial Hermann Texas Medical Center Department of Surgery, University of Texas Houston Medical School, San Antonio Military Medical Center/US Army Institute of Surgical Research San Antonio, Texas<br><br>Ohio Health, Grant Medical Center Columbus, Ohio. | | complication rates. | | | | | | | | | | | |
| Henry, R., Matsushima, K., Henry, R. N., Wong, V., Warriner, Z., Strumwasser, A., Foran, C. P., Inaba, K., Rasmussen, T. E., & Demetriades, D. (2019). Who Would Have Benefited from the Prehospital Use of Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA)? An Autopsy Study. *Journal of the American College of Surgeons*, *229*(4), 383–388.e1. https://doi.org/10.1016/j.jamcollsurg.2019.05.025 | 2019 | 2014-2018 | Division of Acute Care Surgery, University of Southern California, Los Angeles, CA<br><br>F Edward Hebert School of Medicine at Uniformed Services, University of the Health Sciences, Bethesda, MD | USA | We hypothesized that there might be a select group of patients that could have benefited from prehospital placement of the REBOA. | Median Age<br><br>38 (30-58) | Male<br><br>87.7% | Civilian | Military | 73 | An Autopsy Study | An autopsy results revealed that >10% of patients evaluated sustained NCTH of the abdomen and pelvis with previous cause of death noted as cardiac arrest. These patients could have potentially benefitted from REBOA in a prehospital environment. | Addresses the effectiveness of current innovations and gaps in the literature in the management of NCTH with the use of REBOA. | Addresses the potential application of REBOA in the prehospital environment. | Addresses the potential usage of REBOA in the prehospital environment and the potential effects on mortality. | -Prehospital Providers<br>-Emergency Medicine provider |
| Mill, V., Wellme, E., & Montán, C. (2021). Trauma patients eligible for resuscitative endovascular balloon occlusion of the aorta (REBOA), a retrospective cohort study. *European journal of trauma and emergency surgery: official publication of the* | 2021 | 2012-2017 | Department of Medicine and Surgery, Karolinska Institutet, Karolinska Universitetssjukhuset Solna | Sweden | The primary aim of this study was to identify the proportion of possible candidates for | Mean Age<br><br>42 years | Male<br><br>71% | Civilian | | Potential Candidates<br><br>7229 | Retrospective cohort study | REBOA when retrospectively evaluated using and established algorithm may have potential | Addresses the effectiveness of current innovation in an isolate level one trauma | Address the potential application of REBOA in the prehospital and emergency | Addresses the potential usage of REBOA in the Prehospital and Emergency | -Prehospital Providers<br>-Emergency Medicine provider |

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| *European Trauma Society*, *47*(6), 1773–1778. https://doi.org/10.1007/s00068-020-01345-w | | | | | REBOA in civilian trauma, at a Swedish, full-capacity trauma center. A secondary aim was to investigate the validity and usefulness of our own guidelines | | | | | Met criteria for potential use of REBOA<br><br>31 | | indications for usage. However, considering the high mortality rate and increase usage of blood product with REBOA, the number of patients REBOA would benefit is still low. | center in Sweden, Yet the concern for future prospective studies to assess the true indication and roles for REBOA in the management of NCTH. | medicine environment. | Medicine environment. | |
| Northern, D. M., Manley, J. D., Lyon, R., Farber, D., Mitchell, B. J., Filak, K. J., Lundy, J., DuBose, J. J., Rasmussen, T. E., & Holcomb, J. B. (2018). Recent advances in austere combat surgery: Use of aortic balloon occlusion as well as blood challenges by special operations medical forces in recent combat operations. *The journal of trauma and acute care surgery*, *85*(1S Suppl 2), S98–S103. https://doi.org/10.1097/TA.0000000000001966 | 2018 | Unspecified 18-month period | Department of Surgery University of Alabama-Birmingham Medical Center, Birmingham, Alabama<br><br>720th Special Operations Surgical Team, 720th Operations Support Squadron, 720th Special Tactics Group, 24th Special Operations Wing, Air Force Special Operations Command Hurlburt Field, Pensacola, Florida<br><br>Department of Emergency Medicine University of Alabama-Birmingham Medical Center, Birmingham, Alabama<br><br>Department of General Surgery Carl R. Darnall Army Medical Center, Fort Hood, Texas<br><br>Baltimore CSTARS, R Adams Cowley Shock Trauma University of Maryland, Baltimore<br><br>US Department of Defense Combat Casualty Care Research Program, Fort Detrick, Department of Surgery, The Uniformed Services University of the Health Sciences, Bethesda, Maryland<br><br>Department of Surgery Center for Translational Injury Research, UT Health, Houston, Texas. | USA | The objective of this report is to present the single largest series of REBOA use on severely injured combat casualties. | | | Civilian | Military | Combat Casualties<br><br>2300 patients<br><br>Met Inclusion Criteria<br><br>20 | Case Series | REBOA as an initial intervention in DCR and initial surgical hemorrhage control allowed extended capabilities and provided augmented DCR with minimal resources and blood product utilization. | Addresses the effectiveness of REBOA in an austere surgical environment and its effects on mortality. | Address the application of REBOA in the prehospital, Emergency Room and Hospital phases care with decreased morbidity and mortality | Addresses the use of REBOA in austere environments to decrease morbidity and mortality in a combat environment. | -Prehospital Providers<br>-Emergency Medicine provider<br>-Trauma Surgeons |
| ResQFoam Text | | | | | | | | | | | | | | | |
| Chang, J. C., Holloway, B. C., Zamisch, M., Hepburn, M. J., & Ling, G. S. (2015). ResQFoam for the Treatment of Non-Compressible Hemorrhage on the Front Line. *Military medicine*, *180*(9), 932–933. https://doi.org/10.7205/MILMED-D-15-00049 | 2015 | | Strategic Analysis, Inc., Arlington, VA<br><br>Office of Naval Research Global, United Kingdom. | USA<br>UK | Provides discussion and implementation of the ResQFoam for intra-abdominal | | | | Military | | Commentary | Use and implementation of ResQFoam for intra-abdominal hemorrhage | Addresses the effectiveness of current innovations and acknowledges | Address the prehospital POI management of NCTH with ResQFoam intra-abdominal | Addresses the potential management of intra-abdominal hemorrhage | -Prehospital Providers<br>-Emergency Medicine Providers |

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| | | | Science and Technology Associates, Inc., Arlington, VA<br><br>Biological Technologies Office, Defense Advanced Research Projects Agency Arlington, VA<br><br>Uniformed Services University of the Health Sciences, Bethesda, MD | | compression to control intra-abdominal exsanguination hemorrhage. | | | | | | control close to the POI, may provide a means for effective hemorrhage control for patient with NCTH of the abdomen in austere environments. | future innovations for the management of NCTH of the abdomen. | hemorrhage control. | control with ResQFoam | |