The accuracy of Bloemfontein-based Emergency Medical Services providers in recognising sepsis

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ARTICLE INFORMATION

Received: 27 August 2020
Revision received: 14 October 2021
Accepted: 28 November 2021

Keywords:
Pre-hospital
Sepsis
Emergency Medical Services
Screening Tool

ISSN:2709-3786

ABSTRACT

Background: Sepsis is considered a severe life-threatening medical emergency and globally carries a high mortality. Research suggests early recognition of sepsis can lead to early initiation of treatment and effective communication of this condition to the receiving facility by pre-hospital emergency care (PEC) providers. Depending on system operations, this has been shown to improve patient outcomes. However, sepsis often presents non-specifically, and in the absence of validated pre-hospital sepsis screening tools, less than half of sepsis patients seen by PEC providers are recognised. This study aimed to determine the accuracy with which Bloemfontein-based PEC providers recognise sepsis in a series of patient vignettes.

Methods: A series of seven case vignettes were presented to a convenient sample of advanced life support (ALS) and intermediate life support (ILS) PEC providers. The PEC providers were asked to review each vignette and indicate whether the patient described had sepsis or not. The vignettes consisted of a clinical case description with signs and symptoms of patients presenting with or without sepsis, and images were shown where relevant. Elements of the Robson Prehospital Severe Sepsis Screening (RPSS) tool were used to populate the sepsis vignettes.

Results: A total of 27 ILS and ALS PEC providers in the Bloemfontein area partook in the research study. Thus, a total of 189 vignettes were evaluated for sepsis. PEC providers, both ILS and ALS, recognised sepsis with a sensitivity of 69.63% and a specificity of 37.04% (PPV 73.44%, NPV 32.79%), indicating an accuracy of 60.32%. Although all participants mentioned some motivations for their answers, none of the participants gave specific cut-off value ranges at which point they would suspect sepsis.

Conclusion: This vignette-based study found that PEC providers can recognise sepsis with modest accuracy, echoing previous work on this topic. In addition, the study provides a platform for similar studies, which, in turn, could aid in the development of a validated, pre-hospital sepsis screening tool.

Lewis MSP, Jooste W, Campbell R, Stassen W. The accuracy of Bloemfontein-based Emergency Medical Services providers in recognising sepsis. South African Journal of Pre-hospital Emergency Care. 2021; 2(2):3-10. doi:10.24213/2-2-4265

BACKGROUND

Sepsis is considered a severe life-threatening medical emergency with a high risk of morbidity and mortality.[1,2] Globally, there are approximately 30 million cases of sepsis annually, carrying a mortality rate of 35%-40%.[3–5] While many sepsis-related deaths have been prevented through early diagnosis and treatment, it is still the leading cause of emergency department (ED) deaths to date.[2,5,6] Moreover, there is a paucity of research on the prevalence of sepsis in Africa, including South Africa.[2] What is certain is that the prevalence of sepsis in low- to middle-income countries (LMICs) is much higher than in high-income countries (HICs).[3,7] One reason for such high prevalence could be a general lack of access to appropriate healthcare, delaying the treatment of time-sensitive conditions.[8] This is further compounded by inadequate public health education systems,[8,9] and as a result, many patients with uncomplicated infections become septic.[7]

The clinical presentation of sepsis is mostly non-specific,[10,11] making detection difficult. This has contributed to clinicians taking an extended time and requiring more effort to establish a diagnosis and provide essential early sepsis care.[5] Wallgren et al.[12] also found that many people do not receive the appropriate sepsis care, with difficulties in identifying sepsis being a major contributing factor. Research highlights that morbidity and mortality could increase between 4% and 7% with each hour's delay in antimicrobial treatment in hypotensive septic patients.[5,13–16] Ultimately, antimicrobial treatment, early recognition of sepsis and prompt management and resuscitation could prevent up to 80% of sepsis deaths.[17]

Often the first point of medical contact, pre-hospital emergency care (PEC) providers play a crucial role in the initial care and transport of ill and injured patients.[5,18–22] Approximately 75% of sepsis patients seen in the ED are first seen and treated by PEC providers.[5,23,24] Early pre-hospital recognition of sepsis has thus been shown to expedite in-hospital diagnosis and improve compliance with sepsis treatment guidelines.[5,24,25] Furthermore, it has also resulted in a higher likelihood of sepsis patients being transported to appropriate facilities and receiving other critical interventions timeously.[22]

Internationally, data suggest that sepsis recognition by PEC providers is poor,[18,20] with PEC providers only suspecting sepsis in 21%-50% of cases.[18,25] Reasons for such poor recognition may be the non-specific presentation of sepsis[10,11] or the lack of access to imaging and laboratory tests in the pre-hospital setting.[6] Although multiple pre-hospital sepsis screening tools have been designed to aid in recognising sepsis, none have been validated, nor are any currently used in standard practice in South Africa.[12] Research ultimately suggests that routine use of such screening tools in the pre-hospital setting could significantly improve the sensitivity and specificity of sepsis recognition, which has been shown to be far superior to clinical judgement.[12]

Improving sepsis recognition need not be an expensive undertaking and is an important consideration within lower-resource settings. A few small and inexpensive changes within the emergency medical service (EMS) system's care process could significantly impact sepsis patients' care.[20] One such change is to improve PEC providers' ability to recognise sepsis, thereby aiding expedited in-hospital care. There is currently no evidence on how accurately South African PEC providers may recognise sepsis; therefore, this study aimed to determine the accuracy with which Bloemfontein-based pre-hospital providers recognise sepsis in a series of patient vignettes.

DESIGN AND METHODS

Study Design

A prospective, cross-sectional design was used by applying a series of vignettes to a sample of intermediate and advanced life support (ILS, ALS) pre-hospital providers from the city of Bloemfontein, Free State.

Study Population and Sample

Voluntary and convenience sampling was used as participation was dependent on the availability of pre-hospital providers without interrupting service provision. Both private and public sector pre-hospital providers who volunteered participation were eligible. These cadres of providers were purposefully chosen due to their scope of practice and education being commensurate with the management of sepsis.

Methods

The vignettes and a questionnaire were the primary data collection tools. Demographic data were also collected from each participant. The vignettes presented on PowerPoint (Microsoft Corp., Washington, United States of America) were developed using the Robson Prehospital Sepsis Screening (RPSS) tool, and content was validated through a pilot study with three experienced ALS practitioners.

Table 1: Description of Vignettes

Case	**Case Description**	**Vital Signs**	**Sepsis Y/N**
Case 1	A 26-year-old female patient with a recurring UTI is presented. The patient complains of progressive dysuria, urgency, nausea, vomiting, acute pain to the LLQ and fever for the last 2 days.	Temperature: 38°C Heart rate: 131 beats/min; Respiratory rate: 20 breaths/min; Oxygen saturation: 95% on room air; Blood pressure: 95/54 mmHg; HGT: 5.8 mmol/l	No
Case 2	A 62-year-old male patient with an altered mental status (GCS 12/15) is presented. Patient has productive cough, fever, general body weakness, and shortness of breath for the last 3 days.	Temperature: 35.9°C Heart rate: 146 beats/min; Respiratory rate: 28 breaths/min; Oxygen saturation: 90% on room air; Blood pressure: 87/43 mmHg; HGT: 18.1 mmol/l	Yes
Case 3	A 48-year-old female patient with an altered mental status (GCS 14/15) and general body weakness is presented. Patient is 5 days post-surgery. The patient's wound is healing well with no signs of infection.	Temperature:38.9°C Heart rate:128 beats/min; Respiratory rate: 34 breaths/min; Oxygen saturation: 89% on room air; Blood pressure: 111/58 mmHg; HGT: 8.7 mmol/l	Yes
Case 4	A 16-year-old male patient with a foot laceration.	Temperature: 38.1°C Heart rate: 117 beats/min; Respiratory rate: 26 breaths/min; Oxygen saturation: 95% on room air; Blood pressure: 100/58 mmHg; HGT: 7.6 mmol/l	Yes
Case 5	A 28-year-old male patient with recurring sinus infection. Patient has an altered mental status (GCS of 4/15).	Temperature: 38.9°C Heart rate: 130 beats/min; Respiratory rate: 30 breaths/min; Oxygen saturation: 94% on room air; Blood pressure: 123/52 mmHg; HGT: 7.8 mmol/l	Yes
Case 6	A 33-year-old male patient complaining of severe epigastric pain that radiates to the back.	Temperature: 38.1°C Heart rate: 117 beats/min; Respiratory rate: 18 breaths/min; Oxygen saturation: 98% on room air; Blood pressure: 149/91 mmHg; HGT: 6.1 mmol/l	No
Case 7	A 40-year-old female patient complaining of malaise and epigastric pain.	Temperature: 35.2°C Heart rate: 125 beats/min; Respiratory rate: 30 breaths/min; Oxygen saturation: 90% on room air; Blood pressure: 86/41 mmHg; HGT: 9.2 mmol/l	Yes

UTI = Urinary Tract Infection, LLQ = Left Lower Quadrant, HGT = Haemoglucotest, GCS = Glasgow Coma Scale, Underlined denote RPSS elements suggestive of sepsis[10]

These vignettes comprised a combination of elements that entailed a clear description of each case scenario, signs, symptoms and vital signs. Images were included where relevant. Table 1 outlines these vignettes in detail. Although imperfect and largely unvalidated, the RPSS tool has a sensitivity of approximately 95% and specificity of 43% (PPV 97%, NPV 32%).[26] At the time of the study, RPSS was considered the most accurate pre-hospital sepsis screening tool available.

To ensure reliability, all participants were subjected to the same data collection tool under the same conditions. In addition, data collection was completed in the shortest time possible to avoid discussion between colleagues outside the data collection

procedure.

The participants were required to view a PowerPoint (Microsoft Corp., Washington, United States of America) presentation, followed by a questionnaire. After each case was presented, participants had to select between two binary options (Sepsis: Yes or No). Participants were also asked to motivate their answer, outlining on what they based their decision.

Written answers to the vignettes were reviewed by two researchers and extracted into Excel (Microsoft Corp., Washington, United States of America). Accuracy was determined by calculating specificity and sensitivity, and the positive and negative predictive values (PPVs and NPVs) of the participant's diagnosis (index test) – when compared to RPSS (reference standard). In addition, free-text motivations were captured and analysed.

Participants were asked to review and sign an informed consent form that included a confidentiality undertaking prohibiting discussion of the study and contents with others. Ethical approval for this study was obtained from the Durban University of Technology's Human Research Ethics Committee (HREC. Ref Nr. DRC1/2018). In addition, organisational approval was obtained before initiating the research.

Table 2: Demographic Profile of Participants

Demographics	**ALS**	**ILS**	**Total**
Participants, n (%)	8 (30)	19 (70)	27
Years of experience, mean	15.9	9.4	11.3
Monthly patient volume	33	81	66
Monthly patient volume with suspected sepsis	7	7	7

ALS = Advanced Life Support (Critical Care Assistant, National Diploma and Bachelor's Degree), ILS = Intermediate Life Support

RESULTS

A total of 27 responses were returned, yielding a sample of 189 vignettes. Table 2 shows the demographic information of the participants. Tables 3 and 4 show the accuracies of sepsis recognition when compared to the Robson Sepsis Screening tool. The combined (ILS and ALS) group of prehospital providers identified sepsis with a sensitivity of 69.63% and a specificity of 37.04% (PPV 73.44%, NPV 32.79%) respectively, yielding an accuracy of 60.32%. A small sample size precluded a meaningful sub-analysis of ILS and ALS providers.

Table 3: Sepsis Identification by ALS Providers

	RPSS Sepsis, n	**RPSS Non-sepsis, n**	**Total, n**
ALS: Sepsis	31	6	37
ALS: Not Sepsis	9	10	19
Total	40	16	56

ALS = Advanced Life Support, RPSS = Robson Prehospital Sepsis Screening Tool

Table 4: Sepsis Identification by ILS Providers

	RPSS Sepsis, n	**RPSS Non-sepsis, n**	**Total, n**
ILS: Sepsis	63	28	91
ILS: Not Sepsis	32	10	42
Total	95	38	133

ILS = Intermediate Life Support, RPSS = Robson Prehospital Sepsis Screening Tool

Table 5 displays the frequency with which certain features were mentioned to support the diagnosis. Most of the participants used vital signs to identify sepsis – in particular, low blood pressure and fever. No participants reported making use of a screening tool to identify sepsis. Moreover, although vital signs were mentioned, none of the participants gave a cut-off value range, at which point they would suspect sepsis.

DISCUSSION

The increasing importance of the pre-hospital setting's role in identifying sepsis has become more evident in recent research.[11,18,19] This study aimed to evaluate the accuracy with which ILS and ALS PEC providers in Bloemfontein identify sepsis in a series of patient vignettes. The study found PEC providers identified sepsis with moderate sensitivity but with relatively low specificity. No participants reported intentionally using a sepsis screening tool to aid their decision-making; citing vital signs (mainly fever, heart rate, and blood pressure) were the main factors on which sepsis identification was based.

Table 5: Frequency of Diagnostic Features

	Case 1	**Case 2**	**Case 3**	**Case 4**	**Case 5**	**Case 6**	**Case 7**	**Total**
Vitals (Specified)								
Fever	18	6	18	14	10	10	2	78
Heart Rate	17	5	14	7	6	3	6	58
BP (low)	13	9	1	5	0	0	9	37
Respiratory Rate	1	3	7	4	5	0	5	25
HGT	0	9	5	3	3	0	5	25
GCS	0	2	4	0	4	0	2	12
SPO_2	0	1	2	0	2	0	1	6
BP (High)	1	1	0	0	0	1	1	4
No Fever	1	1	0	0	0	0	1	3
Vitals (Unspecified)	3	3	3	1	1	3	1	15
Respiratory Problems[a]	12	3	12	18	8	10	17	80
Infected Wound	0	0	4	16	3	1	2	26
Post-Operative	0	1	5	0	0	0	10	16
Medical History	1	1	3	1	4	2	2	14
Acute Pain	6	0	0	1	0	5	1	13
Signs of Infection	5	1	0	0	1	2	2	11
Recurring UTI	11	0	0	0	0	0	0	11
No Signs of Sepsis[b]	1	1	1	1	2	3	2	11
Nausea/Vomiting	1	0	0	0	0	5	0	6
Clinical/Physical	1	1	0	0	7	10	0	19
Shock	0	0	0	0	0	0	5	5
Peritonitis	0	0	0	0	0	1	0	1

BP = Blood Pressure, UTI = Urinary Tract Infection, LLQ = Left Lower Quadrant, HGT = Haemoglucotest, GCS = Glasgow Coma Scale, a = COPD, Pulmonary Oedema, Pneumonia, Bronchitis,b = Vital signs explained by other causes

Current data suggest PEC providers' recognition of sepsis is often poor worldwide, and there is no research available on how accurately South African paramedics can identify sepsis.[18,20] Although limited by sample size and a single city, this vignette-based study is the first to describe PEC provider sepsis recognition accuracy. This study found that South African PEC providers had a moderately high accuracy in identifying sepsis. According to a cross-sectional, observational study conducted by Polito et al.,[18–20] PEC providers in the USA only had a 17% sensitivity in diagnosing sepsis. The study further highlighted that of all the sepsis patients transported, the providers only had an impression of sepsis in 21% of those patients.[20] While the two studies followed different designs, the dissimilar accuracies may be attributed to several factors. Firstly, due to the high burden of infectious diseases (including sepsis in South Africa and other LMICs), greater exposure might explain the higher accuracy in this study. Secondly, due to the study design, participants might have been primed to look for specific signs of sepsis as they were informed at the start of the questionnaire that they were doing a study on sepsis. This is not the case when a PEC provider is faced with an undifferentiated patient.

In this study, no participants reported using a sepsis screening tool, but this does not denote omission; either intentionally or through ignorance. This is apparent as the top-cited reasons (fever, heart rate and blood pressure) for suspecting sepsis were elements contained in the Robson tool.[26] However, sepsis is difficult to diagnose because the signs and symptoms are mostly non-specific.[8] It

is particularly difficult in the pre-hospital setting, where PEC providers have limited to no access to diagnostic tests and imaging to aid their diagnoses.[21] In conducting this study, numerous tools were suggested with differing accuracies;[10] in this instance, the Robson tool was selected as a reference since it yielded the highest accuracies.[26] However, this tool remains unvalidated in the South African context, where patients present later or with other complex comorbidities.[26] By systematically developing, validating, and implementing a sepsis screening tool for the South African setting, the accuracy with which PEC providers recognise sepsis may be bolstered. Studies have determined sepsis screening tools could help PEC providers identify sepsis in patients with sensitivity and specificity as high as 95% and 93%, respectively.[11] Early sepsis recognition by PEC providers has also been shown to improve in-hospital sepsis diagnosis and expedite treatment;[20,22] in this manner, mortality may be reduced. The effects of these interventions should be evaluated prospectively.

While many features were cited as forming the basis of participants' diagnosis, and notwithstanding the limitation of this study that primed participants to sepsis diagnosis, the true first feature for accurate sepsis diagnosis is a high index of suspicion of sepsis in an unwell patient.[27,28] As mentioned, no discernible screening tool was used to guide participants' diagnosis, but fever, tachycardia, hypotension, and respiratory complaints were the most common features on which diagnosis was based. However, since this study did not seek to explain *why* PEC providers used certain features to confirm or reject a sepsis diagnosis, various explanations are likely.

Firstly, PEC providers may predominantly be trained to manage patients who present with instability or require resuscitation; this might mean a bias towards allocating a sepsis diagnosis to those patients potentially presenting with shock. Shock is a late feature of sepsis that may affect the accuracy of sepsis identification and diagnosis.[5,29] Another explanation of an over-reliance on fever as a feature of sepsis might be due to a clear conceptual link between the notion of infection and fever. This also seems to be the case in the current South African pre-hospital clinical practise guidelines, where the two are presented together.[30] Some of these features (hypotension and fever) were found to be the most pathognomic for hospital-confirmed sepsis in a prospective pre-hospital study in Sweden.[31] However, a recent South African study that sought to identify telephonic descriptors of patients reported gastrointestinal complaints and altered mental status to be the most important features.[32] This common presentation might reflect the high burden of gastrointestinal disease in South Africa versus a greater incidence of respiratory focus of sepsis in higher-income countries.[33,34] The latter may also explain a high reliance on respiratory complaints as an important feature in this study.

Thus, PEC providers require further training to improve their knowledge of sepsis, and the implementation of a sepsis screening tool might be required to bridge this gap. Upskilling pre-hospital providers, even through online learning modules, has been shown to improve treatment guideline adherence in the South African setting.[35]

LIMITATIONS

This study is limited by its design and sampling. Firstly, a vignette-based study may not be a true reflection of the accuracies obtained in actual clinical practice, especially owing to the binary questions that were posed to participants. During actual clinical practice, the question is never binary, and other differential diagnoses will need to be considered. Further, due to a small sample size, the widespread application of the results should be considered cautiously since external validity might have suffered. Participants were also informed that they would be looking for sepsis signs, which could have influenced their performance. The results further only represent a few pre-hospital providers in one city in South Africa.

Additional prospective studies on the accuracy of pre-hospital sepsis recognition should be conducted using patient discharge diagnosis as the gold standard. Further, research on the development and implementation of a pre-hospital sepsis screening tool for the South African setting should be undertaken. Finally, it would also be helpful to determine PEC providers' current knowledge and understanding of sepsis, thus tailoring specific educational interventions.

CONCLUSION

This study suggests modest accuracy in sepsis recognition among a limited subset of PEC providers based on patient vignettes. No participants reported deliberately using a sepsis screening tool to derive an answer, despite citing elements contained within such tools. Research suggests that early recognition and interventions of patients with sepsis significantly improve morbidity and mortality. Future research should prospectively evaluate pre-hospital providers' sepsis recognition accuracy from a larger sample and review whether implementing a validated pre-

hospital sepsis screening tool could improve the recognition of sepsis.

CONFLICTS OF INTEREST

The authors report no conflicts of interest.

AUTHOR CONTRIBUTIONS

ML and WJ contributed to study design, data collection, analysis and interpretation, and reviewed and approved the final manuscript. ML drafted the final manuscript. RC contributed to study design, data interpretation and reviews and approved the final manuscript. WS conceptualised the study and contributed to study design, data analysis and interpretation, and drafted, reviewed and approved the final manuscript.

REFERENCES

1. Levy MM, Evans LE, Rhodes A. The Surviving Sepsis Campaign Bundle: 2018 Update. Crit Care Med 2018;46:997–1000.
2. Jawad I, Lukšić I, Rafnsson SB. Assessing available information on the burden of sepsis: global estimates of incidence, prevalence and mortality. J Glob Health 2012;2:010404.
3. Dugani S, Kissoon N. Global advocacy needed for sepsis in children. J Infect 2017;74 Suppl 1:S61–S65.
4. Al-Orainan N, El-Shabasy AM, Al-Shanqiti KA, et al. Public Awareness of Sepsis Compared to Acute Myocardial Infarction and Stroke in Jeddah, Saudi Arabia: Questionnaire Study. Interact J Med Res 2020;9:e16195.
5. Yealy DM, Mohr NM, Shapiro NI, Venkatesh A, Jones AE, Self WH. Early Care of Adults With Suspected Sepsis in the Emergency Department and Out-of-Hospital Environment: A Consensus-Based Task Force Report. Ann Emerg Med 2021;78:1–19.
6. Green RS, Travers AH, Cain E, et al. Paramedic recognition of sepsis in the prehospital setting: a prospective observational study. Emerg Med Int 2016;2016:6717261.
7. Green RS. Reflections from a canadian visiting south africa: advancing sepsis care in africa with the development of local sepsis guidelines. African Journal of Emergency Medicine 2012;2:90–4.
8. Gonzalez RP, Cummings GR, Phelan HA, Mulekar MS, Rodning CB. Does increased emergency medical services prehospital time affect patient mortality in rural motor vehicle crashes? A statewide analysis. Am J Surg 2009;197:30–4.
9. MacFarlane C, Loggerenberg C van, Kloeck W. International EMS systems in South Africa–past, present, and future. Resuscitation 2005;64:145–8.
10. Wallgren UM, Antonsson VE, Castrén MK, Kurland L. Longer time to antibiotics and higher mortality among septic patients with non-specific presentations–a cross sectional study of Emergency Department patients indicating that a screening tool may improve identification. Scand J Trauma Resusc Emerg Med 2016;24:1.
11. Bayer O, Schwarzkopf D, Stumme C, et al. An early warning scoring system to identify septic patients in the prehospital setting: the PRESEP score. Acad Emerg Med 2015;22:868–71.
12. Wallgren UM, Castrén M, Svensson AE, Kurland L. Identification of adult septic patients in the prehospital setting: a comparison of two screening tools and clinical judgment. Eur J Emerg Med 2014;21:260–5.
13. Seymour CW, Gesten F, Prescott HC, et al. Time to Treatment and Mortality during Mandated Emergency Care for Sepsis. N Engl J Med 2017;376:2235–44.
14. Ferrer R, Martínez ML, Gomà G, et al. Improved empirical antibiotic treatment of sepsis after an educational intervention: the ABISS-Edusepsis study. Crit Care 2018;22:167.
15. Peltan ID, Brown SM, Bledsoe JR, et al. ED Door-to-Antibiotic Time and Long-term Mortality in Sepsis. Chest 2019;155:938–46.
16. Kumar A, Roberts D, Wood KE, et al. Duration of hypotension before initiation of effective antimicrobial therapy is the critical determinant of survival in human septic shock. Crit Care Med 2006;34:1589–96.
17. Mitzkewich M. Sepsis screening in triage to decrease door-to-antibiotic time. J Emerg Nurs 2019;45:254–6.
18. Herlitz J, Bång A, Wireklint-Sundström B, et al. Suspicion and treatment of severe sepsis. An overview of the prehospital chain of care. Scand J Trauma Resusc Emerg Med 2012;20:42.

19. Polito CC, Isakov A, Yancey AH, et al. Prehospital recognition of severe sepsis: development and validation of a novel EMS screening tool. Am J Emerg Med 2015;33:1119–25.
20. Studnek JR, Artho MR, Garner CL, Jones AE. The impact of emergency medical services on the ED care of severe sepsis. Am J Emerg Med 2012;30:51–6.
21. Chowdhury S, Navsaria PH, Edu S, Nicol AJ. The effect of emergency medical services response on outcome of trauma laparotomy at a Level 1 Trauma Centre in South Africa. S Afr J Surg 2016;54:17–21.
22. Guerra WF, Mayfield TR, Meyers MS, Clouatre AE, Riccio JC. Early detection and treatment of patients with severe sepsis by prehospital personnel. J Emerg Med 2013;44:1116–25.
23. Wang HE, Weaver MD, Shapiro NI, Yealy DM. Opportunities for Emergency Medical Services care of sepsis. Resuscitation 2010;81:193–7.
24. Femling J, Weiss S, Hauswald E, Tarby D. EMS patients and walk-in patients presenting with severe sepsis: differences in management and outcome. South Med J 2014;107:751–6.
25. Báez AA, Hanudel P, Perez MT, Giraldez EM, Wilcox SR. Prehospital Sepsis Project (PSP): knowledge and attitudes of United States advanced out-of-hospital care providers. Prehosp Disaster Med 2013;28:104–6.
26. Robson W, Nutbeam T, Daniels R. Sepsis: a need for prehospital intervention? Emerg Med J 2009;26:535–8.
27. Inada-Kim M, Page B, Maqsood I, Vincent C. Defining and measuring suspicion of sepsis: an analysis of routine data. BMJ Open 2017;7:e014885.
28. Marik PE. Don't miss the diagnosis of sepsis! Crit Care 2014;18:529.
29. Evans L, Rhodes A, Alhazzani W, et al. Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock 2021. Crit Care Med 2021;49:e1063–e1143.
30. Clinical practice guidelines. Health Professions Council of South Africa, 2018. (`https://www.hpcsa.co.za/Uploads/EMB/CLINICAL%20PRACTICE%20GUIDELINES%20%20-%20PROTOCOLS-%20JULY%202018.pdf`) (visited on 10/13/2021).
31. Wallgren UM, Sjölin J, Järnbert-Pettersson H, Kurland L. The predictive value of variables measurable in the ambulance and the development of the Predict Sepsis screening tools: a prospective cohort study. Scand J Trauma Resusc Emerg Med 2020;28:59.
32. Stassen W, Larsson E, Wood C, Kurland L. Telephonic description of sepsis among callers to an emergency dispatch centre in South Africa. Afr J Emerg Med 2020;10:64–7.
33. Pillay-van Wyk V, Msemburi W, Laubscher R, et al. Mortality trends and differentials in South Africa from 1997 to 2012: second National Burden of Disease Study. Lancet Glob Health 2016;4:e642–653.
34. Smyth MA, Brace-McDonnell SJ, Perkins GD. Identification of adults with sepsis in the prehospital environment: a systematic review. BMJ Open 2016;6:e011218.
35. Stassen W, Wylie C, Holgate R. An online learning programme improves traumatic brain injury guideline adherence in a South African helicopter emergency medical service. African Journal of Emergency Medicine 2015;5:171–5.