Clinical paper

Oxygen use in low-resource settings: An intervention still triggered by intuition

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Abstract

Background: Although hypoxic patients attending low-resource hospitals have a high mortality, many are not given supplemental oxygen. If oximetry is not available, then the decision to provide oxygen must be based on other factors.

Methods: The variables associated with the decision to provide supplemental oxygen made by an emergency department staff, without access to oximetry, in a low resource Ugandan hospital were determined from data collected within 16h of admission to the hospital’s medical and surgical wards.

Results: Of 2,599 patients, 731 (28.1%) had an oxygen saturation < 95%, and 164 (6.3%) an oxygen saturation < 90%. Of the 731 patients with oxygen levels below 95% 573 (83%) were not given oxygen; oxygen was only given to 63 (38%) of the 164 patients with oxygen saturation < 90%. On average, a patient given oxygen was more likely to die than one not given oxygen, regardless of their oxygen saturation (odds ratio 13.4, 95%CI 9.1 – 19.6). After multivariate analysis weakness, dyspnoea, low oxygen saturation, high heart rate, high respiratory rate, low temperature, alertness, gait, and a medical illness were all significantly associated with the use of supplemental oxygen and in-hospital mortality. Logistic regression modelling of these variables had comparable discrimination for both oxygen use (c statistic 0.88 SE 0.02) and in-hospital mortality (c statistic 0.84 SE 0.02).

Conclusion: The intuitive decision to provide oxygen was strongly associated with in-hospital mortality, suggesting that oxygen was given to those considered the sickest patients. In the future, oximetry may guide oxygen therapy more efficiently.

Keywords: Intuition, Supplemental oxygen, Emergency care, Acute medical care, Low resource settings, In-hospital mortality

Introduction

The presence of hypoxia is a well-recognised predisposing factor for adverse events, such as tachycardia, periodic breathing, “mountain sickness”, impaired memory, fainting, loss of consciousness, intensive care admission and in-hospital mortality. Prior to the availability of oximetry hypoxia was assessed by breathlessness, respiratory distress, cyanosis, vital sign changes and altered consciousness. However, for acutely ill patients without chronic lung disease there is no clear correlation between physical signs and symptoms and oxygenation. At atmospheric pressure normal oxygen saturation is greater than 95%, and most guidelines recommend supplemental oxygen in acutely ill patients to maintain an oxygen saturation level over 94%, with lower levels for those with chronic obstructive lung disease. However, the normal range for oxygen saturation varies according to patient age, and a saturation of 92% may be normal for 70-year-old patients and many authors use 90% as a cut-off for clinically significant hypoxia. Whilst in an emergency resuscitation the empiric administration of oxygen is often life-saving, a large meta-analysis has reported that oxygen saturation levels above 96% are harmful and that prolonged supplemental oxygen should not be used above this
Moreover, although there is a widespread and longstanding custom of giving oxygen for palliation to sick patients regardless of their blood oxygen saturation there is no evidence that oxygen relieves breathlessness in patients who are not hypoxic. Although effective and efficient care is possible, the need for emergency care in low income countries has been neglected as health policies focus on communicable diseases and maternal child health. Of the 29 countries listed by the World Bank as low-income (i.e. per capita annual income less than US$1,035), 22 of them, including Uganda, are in sub-Saharan Africa. For many patients in these countries supplemental oxygen is unaffordable. Moreover, Sir William Osler’s belief that the use of supplemental oxygen “foretold a fatal prognosis” persists in Uganda, where many patients refuse oxygen treatment, or only consent to it when they are in extremis, as they believe it to be a harbinger of death. In addition, the need for oxygen treatment on admission is usually determined after a rapid intuitive assessment without the aid of oximetry by a recently qualified doctor in training.

The purpose of this study was to identify the factors that might influence the use of supplemental oxygen, and if patients might benefit if it were guided by oximetry: it was not to develop or validate a robust predictive score for either oxygen use or in-hospital mortality.

Methods

Aim
to determine the variables associated with the use of supplemental oxygen guided by intuitive clinical assessment without oximetry in a low-resource hospital in a low-income country, and their relationship to in-hospital mortality.

Study design and setting
This retrospective observational non-interventional study was performed on a 46-bed medical ward at Kitovu Hospital, which has 220 beds and is located near Masaka, Uganda, 140 km from the capital city of Kampala. It is a Private Not for Profit (PNFP) Hospital, operated by the Uganda Catholic Medical Bureau. The average charge for a medical admission is US$60, and the income of most patients attending the hospital would be below the average Ugandan per capita annual income of US$1,035. Currently, the hospital has no full-time specialist physician and most emergency medical care is provided by an unsupervised doctors in training. The hospital has no blood gas analysis machine, no intensive care unit, and cannot provide assisted ventilation or renal dialysis. We believe these resources are like those of many hospitals throughout sub-Saharan Africa.

Participants and data collection
From 26th May 2018 to 29th June 2020 the clinical status and vital signs on admission of every patient admitted to the hospital’s medical unit were entered at the bedside using tablet computers into a clinical data management and decision support system (rapid electronic assessment data system [READS], Tapa Healthcare DAC) by three dedicated nurse researchers, who worked in shifts from 9am to 5pm 7-days-a-week.

On the 17th March 2019, the system was expanded to the hospital’s surgical ward. Data were entered twice a day (i.e. morning and evening). Therefore, there could have been a delay of up to 16h between admission to the ward and vital signs being measured.

All patients arrived at the hospital for emergency assessment, and none arrived by appointment or electively. None of the patients were elective admissions, and no patients were excluded from the study (apart from surgical patients admitted prior to 17th March 2019). All patients were initially assessed in the emergency department, which does not have access to an oximeter. The nearby medical ward has one oxygen cylinder and two oxygen concentrators, which are available if not already in use.

READS requires that the patient’s contemporaneous mental alertness, mobility, and complaints to be entered each time the vital signs are measured. This structured bedside assessment requires the recording of pain by site and severity, breathlessness, bleeding, as well as vomiting and diarrhoea. Based on analysis of data previously collected by the system a revised version of the assessment was introduced in May 2018, which included the patients’ subjective feelings of improvement, feelings of weakness, mid-upper arm circumference (MUAC), suspicion of stroke, and HIV status (hospital policy is that all admitted patients should be tested). The patient’s status at discharge (i.e. dead or alive) was also recorded in the system. In total the system currently collects 20 items of data at each assessment. Data entry into the READS system was automatically time and date stamped: there was no missing data as it was impossible to complete a READS assessment without entering all the data required, or to enter values that was outside a plausible range, or to close the assessment without entering the patient’s condition at hospital discharge (i.e. dead or alive).

Oxygen saturation was measure from the finger by the Acc-U Rate CMS 500D oximeter (CMS Mobility Inc., Stafford, Texas, USA). A period from 30 to 60 s was required to obtain a stable pulse and oxygen saturation reading. Impaired mobility on presentation was defined in both cohorts as lack of a stable independent gait when first assessed. Therefore, any patients that were unsteady on their feet, needed a walking stick or other aid to steady themselves, needed help to walk, or were bedridden were considered to have an unstable gait. A patient who was not alert, attentive, calm, and coherent was recorded as “not alert”. HIV status was recorded as known to be negative, positive, or unknown. A feeling of improvement was recorded as “feeling better” or “no improvement”.

Statistical methods and data analysis
All the 20 variables collected at the first READS assessment after admission were analysed. The variables significantly associated with supplemental oxygen and in-hospital mortality were identified by univariate analysis. Logistic regression identified those symptoms and/or signs with odds ratios that remained significantly associated with supplemental oxygen when adjusted for the presence of all the other variables identified to be significantly associated with supplemental oxygen by univariate analysis.

Calculations were performed using Epi-Info version 6.0 (Centre for Disease Control and Prevention, USA). Numeric variables were compared using Student’s t-test and categorical variables were compared using Chi square analysis with Yates continuity correction when applicable. The optimal cut-off to convert continuous variables into a categorical variable was the value with the highest Chi-square for supplemental oxygen use. Adjustment of odds ratios by stepwise logistic regression analysis was performed using Logistic software. The c statistic was used to assess the discrimination of predictive models according to the method of Hanley and McNeil. The p value for statistical significance was 0.05.
Ethics
Ethical approval of the study was obtained from the Scientific Ethics Committee Kitovu Hospital. The study conforms to the principles outlined in the Declaration of Helsinki. The study is reported in accordance with the STROBE statement.

Results
The number of patients given and not given supplemental oxygen
Out of 2599 patients admitted 731 (28.1%) had an oxygen saturation <95%, and 164 (6.3%) an oxygen saturation <90%. A total of 214 (8.2%) patients were given supplemental oxygen. Of the 731 patients with oxygen levels below 95% 573 (83%) were not given oxygen; oxygen was only given to 63 (38%) of the 164 patients with oxygen saturation <90%.

Outcomes of patients given and not given supplemental oxygen
Of the 214 patients given oxygen 122 (57%) had an oxygen saturation ≥95%, and 63 (29.4%) a level ≥90% (Fig. 1). All the patients given oxygen were more likely to die than those not given oxygen, regardless of their oxygen saturation (Table 1a). There was no difference in the mortality of patients with an oxygen saturation from 90 to 94% given oxygen compared to those given oxygen with saturations ≥95%. Similarly, patients not given oxygen with saturations from 90 to 94% had the same mortality as those not given oxygen with saturations ≥95% (Table 1b).

Variables associated with supplemental oxygen use
Patients given oxygen were older, had faster heart and respiratory rates, and lower oxygen saturations and mid-upper arm circumference than those not given oxygen; there was no difference in the length of hospital stay between those given and not given oxygen (6.2 SD 5.8 versus 5.7 SD 5.3 days, p 0.26). The optimal Chi-square determined “cut-off” values for supplemental oxygen use were determined for vital signs and other continuous variables (Table 2).

Of the 20 variables available and/or routinely collected at bedside assessment, only active pain, vomiting, diarrhoea, and bleeding were not associated with supplemental oxygen use (Table 3). Apart from female gender, all the variables associated with supplemental oxygen use were also significantly associated with in-hospital mortality. However, the strongest association with in-hospital mortality of all the variables tested was the use of supplemental oxygen (odds ratio 13.4, 95%CI 9.06–19.72, Chi-square 282.7) (see supplemental data).

Weakness, dyspnoea, oxygen saturation, heart and respiratory rate, temperature, alertness, gait, and a medical illness retained their statistically significant association with in-hospital mortality after adjustment by logistic regression. A predictive model, which assigned one point for every variable’s logistic regression coefficient to the nearest integer (Table 4) had a c statistic for the use of supplemental oxygen of 0.88 SE 0.02 and 0.84 SE 0.02 for in-hospital mortality; these were not statistically different (p=0.10) and the probability of supplemental oxygen use and in-hospital mortality rose together with each point of the score (Fig. 2).

Fig. 1 – Patients in study according to oxygen saturation on admission, provision of supplemental oxygen, and in-hospital mortality. O2 sat = oxygen saturation.
This natural experiment found that 8.2% of patients received supplemental oxygen on admission to hospital, and these patients were more than 10 times likely to die than those not given oxygen. The 83% of the patients with oxygen levels below 95%, albeit measured after a delay of up to 16 h, who were not given oxygen were nearly 8 times less likely to die. Although the intuitive decision to provide oxygen was not guided by oximetry, it did accurately predict in-hospital mortality: a logistic regression model based on those variables that predicted the use of supplemental oxygen also predicted in-hospital mortality.

**Strengths and weaknesses**

The major flaw of this observational study is that we cannot tell how many patients on oxygen with oxygen saturations above the 90% or
Table 3 – Odds ratio for being given supplemental oxygen for each of the 20 variables collected.

| No. | Variable                          | Total (%) | Oxygen given (%) | Odds ratio (95% CI) | Chi-square | p   |
|-----|----------------------------------|-----------|------------------|---------------------|------------|-----|
| 1   | Breathless at rest               | 76 (2.9%) | 56.6%            | 17.92 (10.76 29.90) | 235.61     | <0.0001 |
| 2   | Not improving                    | 419 (16.1%) | 26.7%            | 7.43 (5.47 10.11)  | 213.27     | <0.0001 |
| 3   | O2 sat <90%                      | 164 (6.3%) | 38.4%            | 9.43 (6.49 13.71)  | 206.78     | <0.0001 |
| 4   | Not alert                        | 244 (9.4%) | 32.4%            | 7.87 (5.63 11.01)  | 204.22     | <0.0001 |
| 5   | Respiratory rate >27bpm          | 319 (12.3%) | 28.5%            | 7.00 (5.09 9.62)   | 195.13     | <0.0001 |
| 6   | Unstable                         | 946 (36.4%) | 17.2%            | 6.54 (4.65 9.21)   | 157.46     | <0.0001 |
| 7   | Heart rate >114bpm               | 205 (7.9%) | 28.3%            | 5.68 (3.94 8.13)   | 115.65     | <0.0001 |
| 8   | Feels weak                       | 1857 (71.5%) | 11.3%           | 18.69 (7.34 52.04) | 77.16      | <0.0001 |
| 9   | Suspected stroke                 | 71 (2.7%) | 29.6%            | 5.08 (2.87 8.93)   | 41.15      | <0.0001 |
| 10  | Age >64 years                    | 739 (28.4%) | 13.0%            | 2.2 (1.64 2.97)    | 30.05      | <0.0001 |
| 11  | Medical patient                  | 2047 (78.8%) | 9.5%            | 2.95 (1.78 4.95)   | 20.50      | <0.0001 |
| 12  | Temperature <36.1°C              | 601 (23.1%) | 12.5%            | 1.91 (1.40 2.60)   | 17.92      | <0.0001 |
| 13  | MUAC <24cm                       | 590 (22.7%) | 11.4%            | 1.62 (1.18 2.23)   | 9.32       | 0.002 |
| 14  | Systolic blood pressure <94mmHg  | 344 (13.2%) | 11.9%            | 1.63 (1.11 2.38)   | 6.57       | 0.01  |
| 15  | Female gender                    | 1285 (49.4%) | 9.6%            | 1.42 (1.06 1.91)   | 5.68       | 0.02  |
| 16  | Known to be HIV negative         | 1925 (74.1%) | 7.5%            | 0.71 (0.52 0.98)   | 4.48       | 0.03  |
| 17  | Actively vomiting                | 210 (8.1%) | 4.8%             | 0.54 (0.26 1.06)   | 3.16       | 0.08  |
| 18  | In pain                          | 1353 (52.1%) | 7.4%            | 0.79 (0.59 1.06)   | 2.43       | 0.12  |
| 19  | Current diarrhoea                | 111 (4.3%) | 7.2%             | 0.86 (0.38 1.87)   | 0.05       | 0.82  |
| 20  | Actively bleeding                | 44 (1.7%) | 6.8%             | 0.81 (0.20 2.79)   | 0.00       | 0.95  |

O2sat, oxygen saturation; bpm, beats or breaths per minute; MUAC, mid-upper arm circumference; mmHg, millimetre of mercury

Table 4 – Nine variables that were significantly associated with the provision of supplementary oxygen after adjustment by logistic regression. A simple predictive model was the sum of all the coefficients to the nearest integer.

| Variable                          | Odd ratio (95% CI) | Coefficient | SE | Score points |
|-----------------------------------|--------------------|-------------|----|--------------|
| Feeling weak                      | 8.17 (3.25 20.5)   | 2.1         | 0.47 | 2            |
| Breathless at rest                | 6.63 (3.73 11.79)  | 1.89        | 0.29 | 2            |
| Oxygen saturation <90%            | 4.05 (2.61 6.28)   | 1.4         | 0.22 | 1            |
| Not alert                         | 3.66 (2.44 5.48)   | 1.3         | 0.21 | 1            |
| Heart rate >114 bpm               | 3.21 (2.07 4.99)   | 1.17        | 0.22 | 1            |
| Respiratory rate >27 bpm          | 3.15 (2.16 4.6)    | 1.15        | 0.19 | 1            |
| Unstable gait                     | 2.36 (1.59 3.5)    | 0.86        | 0.2  | 1            |
| Temperature <36.1°C               | 2.31 (1.8 3.33)    | 0.84        | 0.19 | 1            |
| Medical admission                 | 2.06 (1.2 3.53)    | 0.72        | 0.28 | 1            |

Hosmer–Lemeshow goodness of fit statistic χ²=0.49. bpm, beats or breaths per minute.

95% had lower levels before oxygen was started. Data were only entered after the patient was admitted to the hospital, and there may have been a delay of up to 16h between admission to the ward and data collection. Therefore, it is entirely possible that oxygen saturation in the emergency department, had it been measured, would have been significantly different, and altered by subsequent treatment.

This study was performed in a single centre, was relatively small, and only examined in-hospital mortality as no follow-up was possible after discharge. Therefore, the number of patients who may have died shortly after discharge is unknown. The study only included patients who survived to admission and, therefore, did not include moribund patients who died within minutes of arrival at the hospital.

The only candidate variables that could be examined were those collected by the hospital’s current routine assessment made every time vital signs are measured, which contained subjective assessments that may have been prone to bias. Some symptoms and signs not found to be associated with mortality in the past, such as rigors, were not included. It is possible that other factors that were not collected may also have predicted supplemental oxygen use. We were not able to determine, for example, how many patients who needed oxygen refused it or could not afford to pay for it.

**Interpretation**

The purpose of this study was to identify the factors that might influence the use of supplemental oxygen, and not to develop or validate a robust predictive score for either oxygen use or in-hospital mortality. The nine variables of the final predictive model have all already been reported to be associated with mortality: in most hospitals medical patients are more likely to die than surgical patients, apart from those with major trauma; several studies have demonstrated in-hospital death’s association with shortness of breath at rest and a sense of weakness, abnormal vital signs, altered mental status and impaired mobility. The data examined reflected...
The patients’ condition at the time it was collected. In a different cohort of patients 16.3% complained of weakness and 8.6% of breathlessness as a reason for admission, yet neither symptom was associated with an increased risk of mortality. In contrast in this cohort 3% of patient were breathless at rest at the time of they were assessed and were six times more likely to die, while 70% complained of weakness when assessed and were eight times more likely to die. This study also confirms our previous report that patients who feel they were improving have a better outcome. Others have also reported a similar correlation between patients’ subjective feelings and severity of illness.

Clinical relevance

Regardless of their oxygen saturation, this study found that patients given supplemental oxygen had a significantly higher mortality than those not given it. As this difference in mortality was large it is unlikely that any potential damage from oxygen could account for it. The most plausible explanation is that patients given oxygen were either consciously or unconscious recognized as being sicker than those not given it. Guidelines disagree on the saturation level below which supplemental oxygen should be given, ranging from 90% to 95%. If an oxygen saturation of <95% had been used as an indication for oxygen use, nearly 30% of patients would have required it. Very few, if any, low-resource hospitals, or their patients would be able to afford to do this. Without clear evidence of benefit from oxygen therapy for patients with oxygen saturations between 90% and 94%, a practical recommendation for oxygen therapy in low resource settings would be to provide it for all patients with oxygen saturations below 90%. Had this recommendation been followed oxygen supplementation would have been indicated in only 6.3% of our patients, which is less than the 8.2% who were given it in this study.

Fig. 2—Proportion of patients given supplemental oxygen and in-hospital mortality according to the logistic regression model for the prediction of supplemental oxygen use.

Conclusion

In a low-resource hospital in sub-Saharan Africa the intuitive decision to provide supplemental oxygen made without the aid of oximetry was strongly associated with in-hospital mortality. The trained use of oximetry might guide oxygen therapy more efficiently.

Funding and conflict of interest statement

All costs were borne by the authors. John Kellett is a major shareholder, director, and chief medical officer of Tapa Healthcare DAC. The other authors have no potential conflicts of interest.

Authors’ contributions

All authors contributed to the preparation of this paper. LW-K, PN and JK conceived the study; LW-K and PN supervised the collection of the data; IN, JN and TN collected the data and made practical suggestions to ensure its accuracy. JK analysed the data; LW-K, PN and JK drafted the manuscript and critically revised the manuscript for intellectual
content. All authors read and approved the final manuscript and are guarantors of the paper.

**Ethical approval**

Ethical approval of the study was obtained from the Scientific Ethics Committee Kitovu Hospital, which conformed to the principles outlined in the Declaration of Helsinki. Since no interventions were additional to the usual standard of care the need for written consent was waived.

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**Appendix A. Supplementary data**

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.resplu.2020.100056.

**REFERENCES**

1. Haldane JS. A lecture on the symptoms, causes, and prevention of anoxaemia (Insufficient Supply of Oxygen to the Tissues), and the value of oxygen in its treatment. Br Med J. 1919;2(3055):65–71.
2. McGlin H, Adam SK, Singer M. Unexpected deaths and referrals to intensive care of patients on general wards. Are some cases potentially avoidable? J R Coll Physicians: London 1999;33:255–9.
3. Buist M, Bernard S, Nguyen TV, Moore G, Anderson J. Association between clinically abnormal observations and subsequent in-hospital mortality: a prospective study. Resuscitation 2004;62:137–41.
4. Considine J. The reliability of clinical indicators of oxygenation: a literature review. Contemp Nurse 2005;18:258–67.
5. Ahrens T. Changing perspectives in the assessment of oxygenation. Critical Care Nurse 1993;13:78–83.
6. Siemieniuk RAC, Chu DK, Kim LH-Y, et al. Oxygen therapy for acutely ill medical patients: a clinical practice guideline. BMJ 2018;363:k4169, doi:http://dx.doi.org/10.1136/bmj.k4169.
7. Hardie JA, Vollmer WM, Buist AS, et al. Reference values for arterial blood gases in the elderly. Chest 2004;125:2053–60.
8. Bowton D, Scuderi P, Haponik E. The incidence and effect on outcome of hypoxaemia in hospitalized medical patients. Am J Med 1994;97:38–46.
9. Chu DK, Kim LH, Young PJ, et al. Mortality and morbidity in acutely ill adults treated with liberal versus conservative oxygen therapy (IOTA): a systematic review and meta-analysis. Lancet. 2018;391 (10131):1693–705.
10. Abernethy AP, McDonald CF, Frith PA, et al. Effect of palliative oxygen versus room air in relief of breathlessness in patients with refractory dyspnoea: a double-blind, randomised controlled trial. Lancet 2010;376:784–93.
11. Schell CO, Wärnberg MG, Hvarfner A, Högå A, Baker U, Caste gren M, et al. The global need for essential emergency and critical care. Crit Care 2018;22:284, doi:http://dx.doi.org/10.1186/s13054-018-2219-2.
12. Periyayanagam U, Dreifuss B, Hammestedt H, Chamberlain S, Nelson S, Bosco KJ, et al. Acute care needs in a rural sub-Saharan African Emergency Centre: a retrospective analysis. Afr J Emergency Med 2012;2:151–8.
13. The World Bank. World Bank Country and Lending Groups. 2020 (Accessed 04 May 2020, https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lendinggroups).
14. Stein F, Perry M, Banda G, Woolhouse M, Mutapi F. Oxygen provision to fight COVID-19 in sub-Saharan Africa. BMJ Global Health 2020;5:e002786, doi:http://dx.doi.org/10.1136/bmjgh-2020-002786.
15. Warren CPW. The introduction of oxygen for pneumonia as seen through the writings of two McGill University professors, William Osler and Jonathan Meakins. Can Respir J 2005;12:81–5.
16. Stevenson AC, Edwards C, Langton J, Zamawe C, Kennedy N. Fear of oxygen therapy for children in Malawi. Arch Dis Child 2015;100:288–91.
17. Dallal GE. LOGISTIC: a logistic regression program for the IBM PC. Am Stat 1988;42:272.
18. Hanley JA, McNeil BJ. A method of comparing the areas under receiver operating characteristic curves derived from the same cases. Radiology 1983;148:839–43.
19. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA 2013;310:2191–4.
20. Vandenbroucke JP, von Elm E, Altman DG, et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. Epidemiology 2007;18:805–35.
21. Nakitende I, Namujwiga T, Kellett J, Opio M, Lumala A, on behalf of the Kitovu Hospital Study Group. Patient reported symptoms, body temperature and hospital mortality: an observational study in a low resource healthcare environment. QJM 2018;111:691–7.
22. Kellett J, Kim A. Validation of an abbreviated VitalpacTM Early Warning Score (ViEWS) in 75,419 consecutive admissions to a Canadian Regional Hospital. Resuscitation 2011;83:297–302.
23. Bingisser R, Dietrich M, Nieves Ortega R, Malinovska A, Bosia T, Nickel CH. Systematically assessed symptoms as outcome predictors in emergency patients. Eur J Intern Med 2017;45:8–12.
24. Rice B, Leanza J, Mowafi H, et al. Defining high-risk emergency chief complaints: data-driven triage for low- and middle-income countries. Acad Emerg Med. 2020, doi:http://dx.doi.org/10.1111/acem.14013.
25. Bleyer AJ, Vidya S, Russell GB, et al. Longitudinal analysis of one million vital signs in patients in an academic medical center. Resuscitation 2011;82:1387–92.
26. Zadravec FJ, Tien L, Robertson-Dick BJ, et al. Comparison of mental-status scales for predicting mortality on the general wards J. Hosp. Med. 2015;10:658–63.
27. Fritz S, Lusardi M. White paper: “walking speed: the sixth vital sign”. J Geriatr Phys Ther 2009;32:46–9.
28. Wasingya-Kasereka L, Nakitende I, Nabiroyo J, Namujwiga T, Kellett J, on behalf of the Kitovu Hospital Study Group. Presenting symptoms, diagnoses, and in-hospital mortality in a low resource hospital environment. QJM 2020, doi:http://dx.doi.org/10.1093/qjmed/hca1169.
29. Opio Mo, Mutibwa G, Kellett J, Brabrand M, Kitovu Hospital Study Group. Does how the patient feels matter? A prospective observational study of the outcome of acutely ill medical patients who feel their condition has improved on their first re-assessment after admission to hospital. QJM 2017;110:545–9.
30. Albutt A, O’Hara J, Conner M, Lawton R. Can routinely collected, patient-reported wellness predict national early warning scores? a multilevel modeling approach. J Patient Saf. 2020, doi:http://dx.doi.org/10.1097/PTS.0000000000000672.
31. Xie J, Covassin N, Fan Z, et al. Association between hypoxemia and mortality in patients with COVID-19. Mayo Clin Proc. 2020;95:1138–47.
32. Weber MW, Mulholland EK. Pulse oximetry in developing countries. Lancet 1998;351(9056):93.
acutely ill patients admitted to a low-resource hospital in sub-Saharan Africa. Clin Med (Lond) 2020;20:67–73.
34. Sinuff T, Adhikari NK, Cook DJ, et al. Mortality predictions in the intensive care unit: comparing physicians with scoring systems. Crit Care Med 2006;34:878–85.
35. Brabrand M, Hallas J, Knudsen T. Nurses and physicians in a medical admission unit can accurately predict mortality of acutely admitted patients: a prospective cohort study. PLoS ONE 2014;9(7):e101739, doi:http://dx.doi.org/10.1371/journal.pone.0101739.
36. Iversen AKS, Kristensen M, Østervig RM, et al. A simple clinical assessment is superior to systematic triage in prediction of mortality in the emergency department. Emerg Med J 2018;0:1–6, doi:http://dx.doi.org/10.1136/emermed-2016-206382.
37. Weissman DE, Meier DE. Identifying patients in need of a palliative care assessment in the hospital setting a consensus report from the center to advance palliative care. J Palliat Med. 2011;14:17–23.
38. Odell M, Victor C, Oliver D. Nurses’ role in detecting deterioration in ward patients: systematic literature review. J Adv Nurs. 2009;65:1992–2006.
39. Douw G, Schoonhoven L, Holwerda T, et al. Nurses’ worry or concern and early recognition of deteriorating patients on general wards in acute care hospitals: a systematic review. Crit. Care 2015;19(1):230, doi:http://dx.doi.org/10.1186/s13054-015-0950-0955.
40. Consensus statement of the Society of Critical Care Medicine’s Ethics Committee regarding futile and other possibly inadvisable treatments. Crit Care Med 1997;25:887–91.
41. Hui D, Nooruddin Z, Didwaniya N, et al. Concepts and definitions for “Actively Dying,” “End of Life,” “Terminally Ill,” “Terminal Care,” and “Transition of Care”: a systematic review. Journal of Pain and Symptom Management 2014;47:77–89.
42. Bruera S, Chisholm G, Dos Santos R, Crovador C, Bruera E, Hui D. Variations in vital signs in the last days of life in patients with advanced cancer. J Pain Symptom Manage 2014;48:510e517.
43. Hui D, Hess K, dos Santos R, Chisholm G, Bruera E. A diagnostic model for impending death in cancer patients: preliminary report. Cancer 2015;121:3914–21.