

Acute hypercapnic respiratory failure: application of a novel human factors approach to improve recognition and management

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Aims

To improve the recognition and management of acute hypercapnic respiratory failure (AHRF) in hospital inpatients using interventions developed from a novel human factors approach.

Methods

Cases of AHRF were reviewed as safety critical incidents using a human factors approach. Outputs from the case reviews were used to develop a bow-tie model; identifying barriers which facilitate effective management and threats to barriers which compromise patient care. Multidisciplinary workshops were undertaken to discuss how these safety critical barriers could be strengthened and from this the following interventions derived: an automated alert for AHRF, simulation training for doctors and advance care practitioners, management checklists and a referral script, increased use of capillary blood gases and oxygen saturation wristbands.

Data was collected before and after the intervention by retrospective case note review of patients with AHRF (pH <7.35, pCO₂ >6.5) on blood gas analysis.

Results

48 case notes were reviewed pre-intervention and 50 case notes reviewed post-intervention. When comparing data, there was a significant increase in the recognition of AHRF in the post-intervention group (p=0.042). There was also a significant increase in the patients who were prescribed oxygen on ICM; 86% post-intervention versus 55.3% pre-intervention (p<0.001).

In addition, there was a significant increase in an escalation decision in the post-intervention group (p=0.006). 82% of patients had a documented ceiling of care decision versus 56.3% in the pre-intervention group. There was a significant improvement in 30-day mortality (p=0.016) in the post-intervention group but not in inpatient mortality.

Although non-invasive ventilation (NIV) was considered in 76% of patients in the post-intervention group, this was only started in 36% and NIV was only formally prescribed in 44.4% of these patients. 55.6% of patients in the post-intervention group had arterial blood gases taken within 1 hour of starting NIV, compared with 26.3%

Table 1. Management of acute hypercapnic respiratory failure pre- and post-intervention

	Pre-intervention (n=48)	Post-intervention (n=50)	p value
pH, (mean)	7.261	7.263	-
pCO ₂ , (mean)	9.40	10.51	-
pO ₂ , (mean)	12.09	10.05	-
Recognition of AHRF	71.7% (33/46)	84% (42/50)	0.042
Escalation decision	56.3% (27/48)	82% (41/50)	0.006
Oxygen prescription	55.3% (26/47)	86% (43/50)	<0.001
Mean time to NIV	220 mins	195.4 mins	-
ABG within 1 hour of starting NIV	26.3% (5/19)	55.6% (10/18)	0.074
30-day mortality	60.4% (29/48)	36% (18/50)	0.016

ABG = arterial blood gases; AHRF = acute hypercapnic respiratory failure; NIV = non-invasive ventilation.

in the pre-intervention group, but the mean time from admission to NIV was not statistically different pre- and post-intervention (195.4 minutes versus 220 minutes). This may be due to the small number starting NIV failing to show a significant difference.

Conclusion

The interventions developed using a human factors-based method and a 'bow-tie' analysis resulted in improvement in the recognition and management of AHRF and subsequent outcomes. There was significant improvement in the documentation of ceiling of care, oxygen prescription and 30-day mortality. There was no significant improvement in time to NIV or inpatient mortality in this study. Human factors methods and bow-tie analysis could be used in other medical scenarios to improve outcomes. ■

Conflict of interest statement

The authors certify that they have no affiliations or involvement in any entity with any pecuniary or non-pecuniary (personal or professional) interest in the subject matter discussed in this abstract.

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