

Using Eye-Tracking Technology to Capture the Visual Attention of Nurses During Interpretation of Patient Monitoring Scenarios from a Computer Simulated Bedside Monitor

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Introduction:

This study analysed the utility of eye tracking technology for gaining insight into the decision making processes of nurses during their interpretation of patient scenarios and vital signs.

Methods:

Five patient monitoring scenarios (vignette, vital signs [ECG, BP etc.] and scoring criteria) were designed and validated by critical care experts. Participants were asked to interpret these scenarios whilst 'thinking aloud'. Visual attention was measured using infrared light-based eye-tracking technology. Each interpretation was scored out of 10. Subjects comprised of students (n=36) and qualified nurses (n=11). Scores and self-rated confidence (where 1=low, 10=high) are presented using mean±SD. Significance testing was performed using a t-test and ANOVA where appropriate ($\alpha = 0.05$). Multivariate regression was performed to determine if a machine could use eye gaze features to accurately predict competency (dependent variable=score). Independent eye gaze only variables were used in the regression models if they statistically significantly ($p < 0.05$) correlated with the score.

Results:

Scores across all scenarios were calculated (students=4.58±1.13 vs. qualified=6.85±0.82) with statistical significance between groups ($p < 0.01$). Mean self-rated confidence was also calculated (students=5.79±1.05 vs. qualified=7.49±1.00, $p < 0.01$). There was a weak positive correlation between confidence and score amongst students ($r = 0.323$, $p = 0.06$), although no meaningful correlation with qualified nurses ($r = -0.099$, $p = 0.77$). However, for all participants there was a moderate correlation between confidence and score ($r = 0.592$, $p < 0.01$).

The fitness of the regression models for predicting competency based on eye gaze features only is as follows:

- Scenario 1: $R^2 = 0.407$, Std Error=1.243 ($p = 0.09$)
- Scenario 2: $R^2 = 0.746$, Std Error=1.439 ($p = 0.01$)
- Scenario 3: $R^2 = 0.385$, Std Error=1.564 ($p = 0.03$)
- Scenario 4: $R^2 = 0.687$, Std Error=1.340 ($p = 0.44$)
- Scenario 5: $R^2 = 0.766$, Std Error=0.960 ($p = 0.02$)

The following table also shows where subjects fixated the most and least on the different vital signs on the bedside monitor (note the lower fixation duration on the ECG by students in comparison to qualified nurses).

Table 1 - Total fixation duration on the different areas on screen.

Group	Order of Highest Fixation Duration	Areas on Screen	Mean %	SD (seconds)
Qualified Nurses	1	ECG	30%	25.37
	2	Arterial Blood Pressure	28%	22.71
	3	Oxygen Saturation	22%	18.65
	4	Central Venous Pressure	9%	7.22
	5	Temperature	6%	5.38
	6	Respiratory Rate	5%	4.95
Student Nurses	1	Arterial Blood Pressure	33%	18.95
	2	Oxygen Saturation	20%	12.52
	3	ECG	17%	13.54
	4	Central Venous Pressure	13%	11.49
	5	Temperature	9%	4.97
	6	Respiratory Rate	8%	6.43
Area on Screen			t-test	
ECG			0.07	
Arterial Blood Pressure			0.50	
Oxygen Saturation			0.77	
Central Venous Pressure			0.07	
Temperature			0.08	
Respiratory Rate			0.13	

Conclusion:

The study has shown that eye-tracking measurements can provide insight into the decision-making of nurses and can be used to predict competency.