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Evaluation of an automated facial recognition software application for assessment of pain among chronic pain sufferers

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Background and aims: Pain management amongst patients with cognitive dysfunction (e.g. dementia) is problematic, particularly when the carer shares the responsibility of providing analgesia. Numerous pain scales have been developed to assist carers to assess patients' pain status; most of which include items derived from the American Geriatric Society Guidelines of Persistent Pain 2002. To reduce the subjective nature of these scales, we have developed a world's first hybrid model (and mobile app) of pain assessment, which comprises automated facial and non-automated (non-facial) indicators. The electronic Pain Assessment Tool (ePAT) is an app integrated in a smart device. This validation study aims to assess the feasibility of using the facial domain of the ePAT in cognitively intact chronic pain sufferers and subsequently inform its future use in cognitively impaired people.

Methods: Participants (n= 43, [21 male, 22 female], mean age= 54 ±14) with chronic pain were recruited from various primary care settings including pharmacies and GP clinics using purposive sampling. Each participant completed a pain questionnaire, derived from consensus recommendations of the international interdisciplinary experts on assessment of pain in older adults. The questionnaire included self-rating scales - the Visual Analogue Scale (VAS), the Numerical Rating Scale (NRS) and the Verbal Descriptor Scale (VDS), which are validated measures of pain. The researcher (MA) who administered the ePAT was blinded to the questionnaire responses. Facial assessments using the ePAT were undertaken within 5 minutes of the participant completing the questionnaire. The ePAT identified whether each of 9 different facial action units (AU) demonstrated pain. Correlation between the total number of AUs recording signs of pain (AU score) and each of the standard pain scores (VAS, NRS, VDS) was performed. Sensitivity and specificity of the AU score to identify people with moderate to severe pain (based on the validated measures) was examined.

Results: When the AU score was classified into two groups (0-2 vs 3 or more), it was highly correlated with the questionnaire measures of pain (t-tests or Wilcoxon: $p<0.0001$ for each measure). These measures were then classified into two groups (low or high pain) as follows: VAS: 0-50 vs 51-100; VRS: 0-3 vs 3.5-5; NRS: 0-4 vs 5-10. Cross tabulations of the categorised AU score against these binary variables showed that a high AU score had over 95% sensitivity to identify high pain scores, and high specificities (69%, 90%, 95% for each measure). Participants were classified into those recording high pain on any of the 3 validated measures vs low pain on all measures. The AU score was able to identify high pain with 95.7% sensitivity and 95% specificity.

Conclusions: The ePAT was able to identify the distinctive facial patterns associated with chronic pain with high sensitivity and specificity. The ePAT was easy and quick to administer, and holds a great promise for the assessment of pain in the cognitively impaired.

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