# Improving Provider Pain Assessment with Nociceptive Level Index Technology

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## Background

- Significant population for whom self report pain measures are unreliable or unattainable.[1]
- Pain often undisclosed secondary to cognitive and communication impairments:
  - Neurologic injury such as stroke
  - Sedated/anesthetized post-operatively or in the ICU
  - Traumatic Brain Injury
  - Cognitive decline, dementia, Alzheimer's Disease
- Non-invasive, objective continuous pain measures can change current treatment paradigms for those unable to self-report pain.
- When used intraoperatively, Nociceptive Level Index® (NOL)-guided opioid dosing resulted in improved hemodynamics and reduced postoperative pain.[2-3]
- Preliminary studies demonstrate NOL technology can also detect nociception in awake ICU patients and patients with complex regional pain syndrome.[4]
- Our aim is to demonstrate the critical need for validated, non-invasive objective, quantifiable, continuous pain assessment technology such as the FDA approved Nociception Level Index® (Medasense Biometrics, Israel).

## Methods

- Sample: 824 patients with a discharge diagnosis of stroke admitted to a large, urban university based, acute care facility in Texas with a completed pain assessment (Numeric Rating Scale [NRS], Behavior Pain Scale [BPS], or Medication Administration Record NRS [MAR]) at discharge.
- Descriptive analysis of means and frequency distributions was conducted using a two-sided t-test for continuous variables and a Chi-squared test for categorical variables.
- Univariable and multivariable logistic regression models were used to determine the association between pain at discharge and type of stroke, adjusting for age, sex, race, smoking status, prevalent hypertension, BMI, and length of stay (LOS).
- We also tested for statistical interactions between stroke type and age, sex, and race.

## References

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## Results

*Table 1. Descriptive analysis of means and frequency distributions of covariates by pain status at discharge.*

| | No Pain at Discharge (n = 466; 56.6%) | Experienced Pain at Discharge (n = 358; 43.4%) | P-Value |
|---|---|---|---|
| **Mean Age[a]** | 69.0 (sd=14.6) | 59.9 (sd=15.9) | **<0.001** |
| **Mean BMI[a]** | 28.2 (sd=6.8) | 30.2 (sd=13.4) | **0.009** |
| **Mean Length of Stay[a]** | 8.2 (sd=10.3) | 12.1 (sd=11.4) | **<0.001** |
| **Sex[b]** | | | 0.187 |
| **Male** | 257 (55.2%) | 180 (50.3%) | |
| **Female** | 209 (44.8%) | 178 (49.7%) | |
| **Race-Ethnicity[b]** | | | 0.151 |
| **White/Caucasian** | 159 (34.1%) | 137 (38.3%) | |
| **African American** | 131 (28.1%) | 80 (22.3%) | |
| **Other** | 152 (32.6%) | 123 (34.4%) | |
| **MHH Campus[b]** | | | **0.018** |
| **TMC** | 341 (73.2%) | 280 (78.2%) | |
| **The Woodlands** | 71 (15.2%) | 57 (15.9%) | |
| **Southeast** | 54 (11.6%) | 21 (5.9%) | |
| **Ever Smoked[b]** | | | 0.357 |
| **Yes** | 85 (18.2%) | 55 (15.4%) | |
| **No** | 380 (81.5%) | 298 (83.2%) | |
| **Prevalent Hypertension[b]** | | | 0.274 |
| **Yes** | 454 (97.4%) | 343 (95.8%) | |
| **No** | 12 (2.6%) | 15 (4.2%) | |
| **Stroke Type[b]** | | | **<0.001** |
| **Ischemic** | 371 (79.6%) | 213 (59.5%) | |
| **Hemorrhagic** | 95 (20.4%) | 142 (39.7%) | |

*Table 2. Univariate and multivariate logistic regression results for the overall cohort.*

| | Crude OR (95% CI) | p-value | Adjusted OR (95% CI) ROC AUC = 0.716 | p-value |
|---|---|---|---|---|
| **Age** | 0.97 (0.96-0.98) | **<0.001** | 0.97 (0.96-0.98) | **<0.001** |
| **BMI** | 1.03 (1.01-1.05) | **0.004** | 1.03 (1.01-1.05) | **0.008** |
| **Length of Stay** | 1.04 (1.02-1.05) | **<0.001** | 1.03 (1.01-1.04) | **0.001** |
| **Sex** | | | | |
| **Male** | 0.82 (0.62-1.08) | 0.165 | 0.34 (0.19-0.61) | **<0.001** |
| **Female** | Ref | Ref | Ref | Ref |
| **Race-Ethnicity** | | | | |
| **White/Caucasian** | Ref | Ref | Ref | Ref |
| **African American** | 0.71 (0.49-1.01) | 0.061 | 0.56 (0.37-0.83) | **0.004** |
| **Other** | 0.94 (0.68-1.31) | 0.709 | 0.75 (0.52-1.08) | 0.124 |
| **Ever Smoked** | | | | |
| **Yes** | 0.83 (0.57-1.19) | 0.311 | 0.80 (0.52-1.22) | 0.310 |
| **No** | Ref | Ref | Ref | Ref |
| **Prevalent Hypertension** | | | | |
| **Yes** | 0.60 (0.27-1.31) | 0.201 | 1.12 (0.45-2.85) | 0.805 |
| **No** | Ref | Ref | Ref | Ref |
| **Stroke Type** | | | | |
| **Ischemic** | 0.38 (0.28-0.52) | **<0.001** | 0.26 (0.15-0.43) | **<0.001** |
| **Hemorrhagic** | Ref | Ref | Ref | Ref |
| **Stroke Type * Sex** | | | | |
| **Ischemic, Male** | -- | -- | 3.01 (1.52-6.03) | **0.002** |

- Mean age was 64 years, with 56% (n=462) being males (Table 1).
- Of the 824 stroke patients, 584 (71%) had ischemic stroke while 237 (29%) had hemorrhagic (ICH) stroke (Table 1).
- At discharge, 43% (n=358) reported pain (Table 1).
- In unadjusted analyses, those reporting pain were younger (p<0.001), had a higher BMI (p=0.009), had longer LOS (p<0.001), and were less likely to have ischemic stroke (p<0.001) (Table 2).
- In sex-stratified analysis females with ischemic stroke had lower odds of reporting pain at discharge by 75% compared to females having ICH (OR=0.25; 95% CI: 0.15-0.41) (Table 2).
- 102 (11.1%) of the 821 stroke survivor cohort had neither an admission nor a discharge pain scale recorded

## Limitations

- Assuming missingness at random, we only included facilities with more complete data ascertainment; therefore, reducing the overall sample size.
- 3 pain scales utilized in analysis: NRS, BPS, MAR. NRS and MAR are both self-reported pain scales. The BPS is an observer pain rating scale which may not accurately reflect patient's pain..

## Conclusions

- Despite inconsistent and missing pain assessments throughout admission, 43% of stroke survivors reported pain at discharge demonstrating a need for improved pain assessment methods particularly those with impaired ability to self-report.
- Currently available object pain measures are costly and/or laboratory based techniques: biological samples for stress hormones, EEG, EMG, fMRI.
- NOL index technology utilizes a simple, disposable finger probe to collect and combine autonomic variables known to change with nociception:
  HR, HRV, skin conductance, photoplethysmography amplitude.

*Figure 1 - PMD-200 monitor with NOL technology*

- ***Non-invasive, objective measures of pain are critically needed in pain management and can change the landscape of pain assessment and treatment thereby supporting ERAS programs.***