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► **To cite this version:**

Clara Charon, Pierre-Henri Wullemin, Joël Belmin. Improving Pressure Ulcers Prediction in Nursing Homes with ML Algorithm. MIE 2023, May 2023, Göteborg, Sweden. pp.350-351, 10.3233/SHTI230135 . hal-04108984

HAL Id: hal-04108984

<https://hal.sorbonne-universite.fr/hal-04108984>

Submitted on 30 May 2023

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Improving Pressure Ulcers Prediction in Nursing Homes with ML Algorithm

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Abstract. An automated ML classifier predicting pressure ulcers one-month before performs better than the reference methods currently used in nursing homes.

Keywords. Machine Learning, Nursing Homes, Braden Scale, Pressure Ulcers

1. Introduction and Methods

As the population ages, the prevalence of chronic disease and disability increases, and the number of older adults living in nursing homes (NHs) grows. NH residents are a high-risk population for developing pressure ulcers (PU), which are skin injury related to immobility and ischemia induced by prolonged pressure and microvascular compression. This condition causes pain, infection and impaired quality of life. Treatment of PU is difficult, expensive and time consuming for nurses, but it is highly preventable with a specific, multidisciplinary approach [1]. A large database of electronic health records (EHR) from a NH software² allowed us to create a classifier made using machine learning (ML) and specifically Bayesian networks (BN) [2], that accurately predicts PU based on data available one month prior to PU onset [3]. To assess the risk of PU, NH staff currently use clinical tools such as the Braden or Norton scales which are considered the reference, even if they have been criticized [4]. We identified residents in the database who had a risk assessment for PU by the Braden scale (which was more widely used than the Norton scale). It gave us the opportunity to compare its finding with our BN classifier calculated at the same time and sample and in the rest of the residents. The risk prediction by the Braden scale (with a cut-off of 12) and the BN classifier were compared with the presence/absence of PUs one month later.

2. Results and Discussion

Among the 37,231 residents analysed in our database, only 2,110 (5.6%) had a Braden scale PU risk assessment. Among them, 695 residents (33%) suffered from PU a month

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² This research is funded by Teranga Software and the ANRT CIFRE Grant n°2019/1519 for CC and was approved by the CESREES of the Health Data Hub (#9458633).

later. This contrasted with the lower PU occurrence (5,656; 16%) among the 35,121 residents which were not assessed by the Braden scale, indicating that the use of the Braden scale was yet an indicator of a high-risk for PU, independently of its result. It is likely that NH staff realized PU risk assessment by the Braden scale on the basis of their clinical awareness. Sensitivity, specificity, positive and negative predictive values based on the confusion matrices of risk assessments by the Braden scale and the BN classifier obtained in the residents assessed by the Braden scale (higher-risk sample) as well as the BN classifier in the rest of the NH residents (lower-risk sample) are shown in Table 1.

Table 1. Scores of Braden Scale and BN Classifier in the higher-risk (HR) and in the lower-risk (LR) sample.

	Braden scale	BN Classifier (HR)	BN Classifier (LR)
Sensitivity	0.15	0.99	0.86
Specificity	0.91	0.01	0.91
Positive predictive value	0.46	0.33	0.65
Negative predictive value	0.69	0.83	0.97

The performance of the Braden scale was poor, as its sensitivity was 0.15, indicating that the scale strongly underestimated the risk of PU. The performance of the BN classifier in the lower-risk sample of residents was clearly better, with higher positive and negative predictive values. However, in the higher-risk sample, the BN classifier had low specificity and positive predictive value, indicating that the clinical awareness of the nurses who decided to perform the Braden scale captured most of the information provided by the BN classifier. These results highlight the importance of the clinical awareness of healthcare professionals, but it should be noted that their determinants are not known and cannot be easily translated into decision rules. The main limitation of our study is related to the rather small percentage of residents assessed by the Braden scale, selected on the basis of the clinical awareness of the nursing staff. In addition, we cannot exclude that in residents with a positive Braden scale score, nurses implemented care processes to prevent PU and, therefore, reduce its incidence. Thus, a better comparison of the performance of the Braden scale and the ML algorithms would have been better achieved by assessing the risk of PU by both methods on a random sample.

3. Conclusion

For PU risk assessment, the BN classifier performed much better than the gold standard: the Braden scale, which had low sensitivity and underestimated PU risk in a large proportion of residents. We observed that the nurses' clinical awareness that led them to perform a risk assessment by the Braden scale has an interesting predictive value which is found almost perfectly by the BN classifier. Our method had also fine results on the lower-risk sample, making it a legitimate support in the decision of the population at risk.

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