Deep Learning-Based Application for Pressure Injury Management

- Samsung Medical Center -

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Executive Summary

- Pressure injuries (PIs) are localized damage to the skin and underlying soft tissue, often occurring over bony prominences or in association with medical devices. PIs are classified into six stages (Stages 1-4, Unstageable, and Deep Tissue Injury) based on the depth and type of affected tissue.

- PIs can lead to negative outcomes such as prolonged hospital stays, increased medical costs, and delayed recovery, thus worsening patient prognosis. Therefore, the incidence and prevalence of PIs are critical indicators used to evaluate the quality of healthcare institutions. Various scales are used to assess the prevention and treatment of PIs, with the Pressure Ulcers Scale for Healing (PUSH) Tool and the Bates-Jensen Wound Assessment Tool (BWAT) being the most widely used. (Gunes, U. Y., 2009. A Prospective Study Evaluating the Pressure Ulcers Scale for Healing [PUSH Tool] to Assess Stage II, Stage III, and Stage IV PIs. *Ostomy/Wound Management,* 55(5), 48). Utilizing these tools is crucial for evaluating the effectiveness of PI-prevention interventions implemented by nurses. At Samsung Medical Center (SMC), the PUSH score is used to assess PI status, progression, and deterioration.
  SMC has developed a deep-learning based application that supports nurses in assessing PI stages and recommends appropriate dressing materials for each stage.

This app, integrated into a BPOC (Barcode-enabled Point of Care, a handheld patient identification barcode system), transmits the recorded data in real-time to the hospital's electronic medical records (EMR) system.

- To evaluate the app's effectiveness, we compared the PUSH scores between app users and non-users. PI wound healing was determined by the improvement in PUSH scores from the initial assessment to a follow-up at seven days. Since the PUSH score decreases as healing occurs, we defined negative changes as an improvement. A chi-square test was employed to determine differences between the groups, with statistical significance set at $P<0.05$.

  The study found that for PIs at Stage 2 and above, the app user group showed 37% higher healing rate than the non-user group.

Define the Clinical Problem and Pre-Implementation Performance

- **Clinical Importance**

  - PIs are a significant concern in patients with limited mobility, the elderly, and critically ill patients. PIs reflect the quality of care provided by hospitals and are used internationally as a key nursing quality indicator.

  - At Samsung Medical Center, when a PI is identified, nurses follow a workflow based on its severity. PIs of Stage 2 or above are reported to the nurse manager, and those at Stage 3 or above are referred to WOCNs (Wound, Ostomy, and Continence Nurses) for specialized care. The hospital follows the guidelines set by the National Pressure Injury Advisory Panel to ensure the prevention and treatment of PIs.

  - PIs can lead to serious consequences, negatively affecting patient's prognosis. Several national institutions present PI incidence rates as key quality indicators for healthcare institutions. The incidence of PIs is a critical nursing quality indicator internationally, making it essential to implement standardized strategies for PI prevention and management.

  - PI prevention at SMC includes comprehensive skin assessments upon admission, utilizing the Braden scale and regular monitoring by nurses. Preventive measures, such as repositioning immobile patients and applying dressings to certain areas, are implemented for patients identified as at high risk.

  - Since 2022, we have implemented a Pressure Injury Clinical Decision Support System (CDSS) to identify high-risk patients and provide personalized preventive interventions (Fig 1). The CDSS is updated hourly to reflect changes in patient conditions, enabling nurses to offer timely interventions.

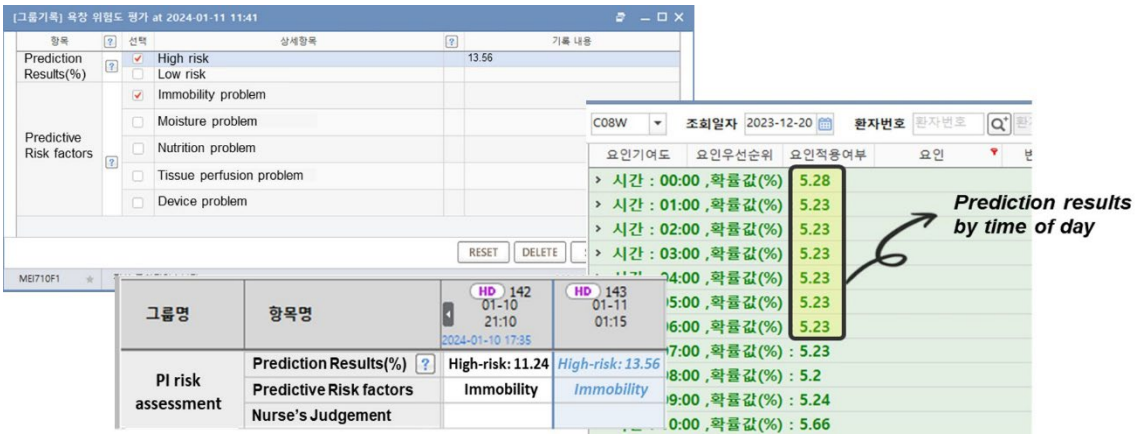

Fig 1. SMC's Clinical Decision Support System (CDSS) for PIs

- Additionally, we operate a dashboard that intuitively visualizes the current status of PI management and the use of preventive resources (Fig 2). Both nurse managers and nurses have access to this dashboard, which provides an overview of PI occurrences, the proportion of high-risk patients, and the PI prevention interventions administered by each nursing unit. The dashboard allows nurses to connect predicted PI risk results with nursing interventions, enabling real-time monitoring to ensure that preventive measures are being effectively implemented.

Fig 2. The dashboard intuitively visualizes the current status of PI management and the use of preventive resources at SMC.

- These efforts to manage and prevent PIs have resulted in a severe PI incidence rate of approximately 0.09%, a figure that is significantly lower than global averages (Dangerous bed sores, Average hospital's score [USA]: 0.58%, (Fig 3), according *to Mayo Clinic-Rochester Safety Problems*, 2024). The incidence rates of PIs for other tertiary hospitals in South Korea are not disclosed to the public. The only PI incidence rates

provided by national institutions are those for convalescent hospitals where rates range from 0.1% to 0.14%. However, given the significant differences in patient populations between convalescent hospitals and tertiary hospitals like Samsung Medical Center in terms of severity and acuity, direct comparisons between these institutions are inappropriate.

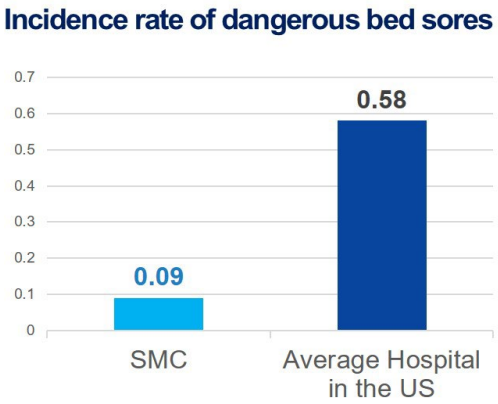

Fig 3. Incidence rate of dangerous PIs at SMC

- As one of the top hospitals in the South Korea, SMC attracts a significant number of severe patient cases from across the nation. Many of these patients are admitted with preexisting PIs, leading to an annual PI prevalence rate of approximately 7.5%. Therefore, even though the incidence rate of PIs is very low, the number of pressure injuries that nurses must manage is not small. It is crucial to consistently support nurses in providing adequate care for these existing PIs.

- **Clinical Usefulness**

  - Before discussing PI management at Samsung Medical Center, it is important to understand the clinical nursing environment in Korea. Due to low reimbursement rates from Korea's national health insurance, the nurse-to-patient ratio in med/surg units ranges from 1:8 to 1:12, and from 1:2 to 1:3 in ICUs. This means that nurses in Korea tend to care for more patients compared to their counterparts in North America. Additionally, nurses are involved in a variety of tasks, including respiratory therapies and the management of supplies and materials within the nursing unit as well as administering medications, monitoring vital signs, recording food intake, preventing and managing falls, and preparing for tests and procedures.

  - Nurses are responsible for managing PIs, from assessing the size and stage of the injury to selecting and applying the appropriate dressing. The result of the assessment and the dressing materials used are recorded on the EMR. The nurse's knowledge and experience heavily influence the outcomes of PI management.

  - Various training programs, EMR-based guidelines, and handbooks are available, but they often have limitations in terms of accessibility and ease of use. To address

this, we developed a new system for PI management that allows standardized care regardless of the nurse's experience level, and without requiring specialized equipment (that may have compatibility issues with EMR system). Therefore, we aimed to implement a method in the clinical environment that would use existing equipment and maintain compatibility with EMR systems, resulting in better outcomes for PI management.

- **Technical Feasibility**
  - At Samsung Medical Center, all bedside nurses use BPOC devices for real-time documentation of patient assessments and interventions at the bedside. These devices, equipped with cameras, are fully integrated with the EMR system and provide a suitable platform for our PI management app.

Design and Implementation Model Practices and Governance

- **Objectives**
  - The main objective of this deep-learning based application for PI management was to enable nurses to accurately determine PI stages and select appropriate dressing materials, ultimately improving patient outcomes.

- **Timeline**
  - We extracted EMR data, de-identified images, and developed an annotation tool, followed by image boxing and annotation modification. After consulting experts to develop a dressing recommendation algorithm, we built a cloud analysis environment and developed an AI model by external collaboration. Processes such as removing dark images were performed to improve accuracy. We also reviewed annotation errors and developed the app. Following a year-long test of the prototype in 14 units, the application was expanded to all inpatient units. (Fig 4).

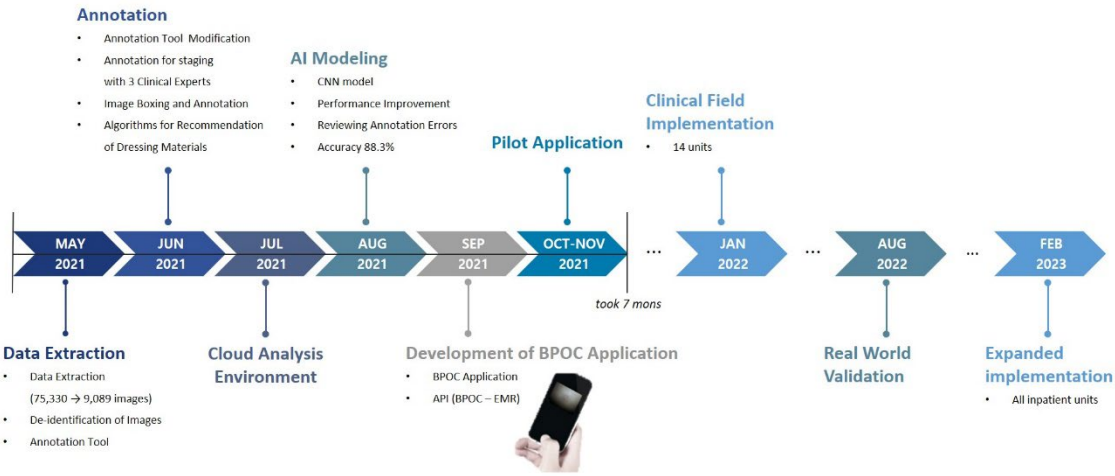

Fig 4. Timeline for development of a deep-learning AI app for PI management

- **Stakeholders and Roles**

  - The principal investigator led data cleaning, anonymized data, and developed the dressing recommendation algorithm.
  - The nursing professional development team (Nursing QI Team) contributed to app design, data cleaning and annotation.
  - WOCNs provided guidance on dressing methods for each PI stage.
  - Participating researchers engaged in data cleaning and data anonymization.
  - The infrastructure operations team managed the development of the BPOC app and its integration with the EMR system.
  - The app development company provided the annotation tool, guided its usage, handled AI modeling, and developed the application.
  - Bedside nurses provided feedback on the app's usability as end users.

- **Technical Description**

  - We used 9,039 PI images and EMR data to develop this application. The images were standardized to a resolution of 512 x 512 pixels. The PI staging model was based on a Convolution Neural Network (CNN), trained on data split into training, validation, and testing sets in a 7:1:2 ratio.
  - Wound-care specialists with over 10 years of experience annotated the PI areas in these images.
  - An API was developed to connect the app to the EMR system.

- The final algorithm consists of 29 scenarios that consider PI stage, suspected infection, surrounding skin condition, presence of undermining, and amount of exudate. Impractical combinations and redundancies based on PI stage characteristics were eliminated. The system recommends one of 19 available dressing types based on the analysis of each algorithm.

- The AI model's performance exceeded that of clinical nurses (Fig 5). In real-world validation, the AI model also outperformed the nurses (Fig 6).

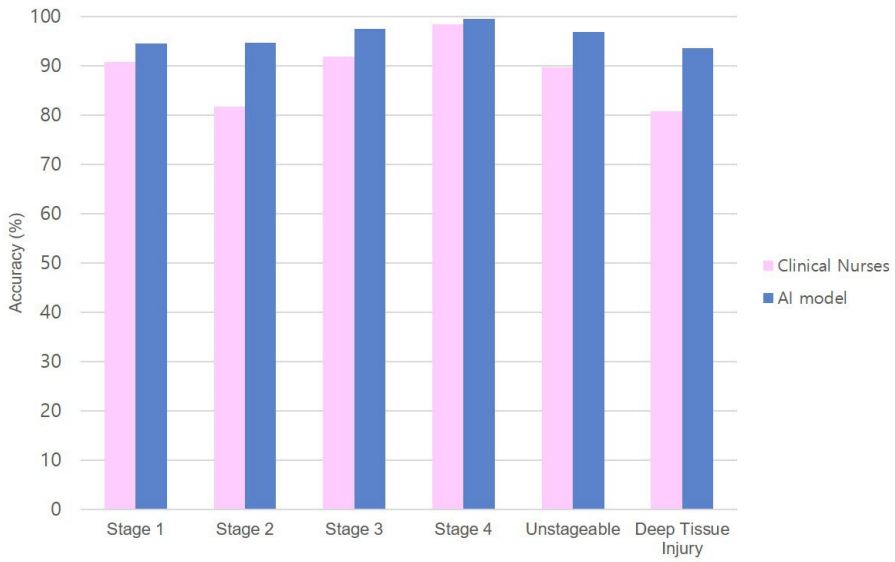

Fig 5. Clinical nurses vs. AI performance after modeling

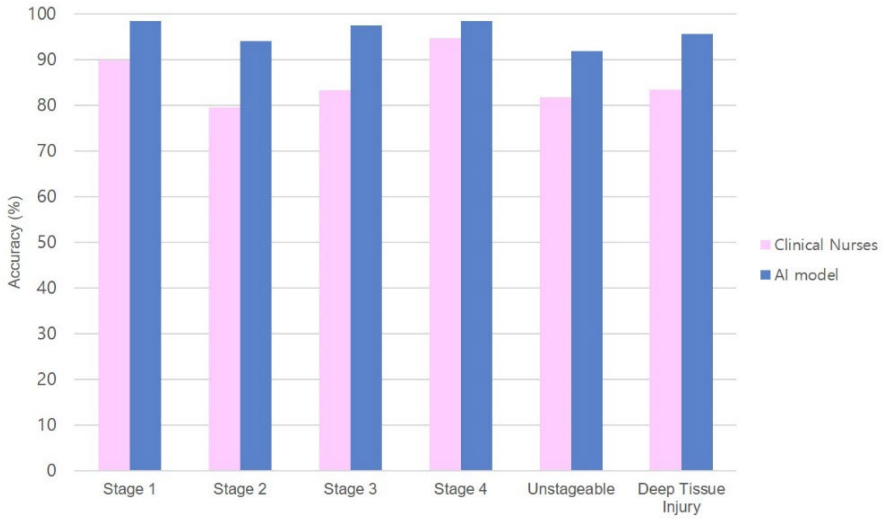

Fig 6. Real-world validation after app implementation (2022)

- The loop time from the user's confirmation of the captured PI image to the AI prediction of the PI stage is approximately 0.458 seconds. The loop time from

confirmation of the AI-predicted PI stage to completion of the dressing recommendation is around 0.071 seconds.

- **Standard of Care for Use of the App**
  - Checking and documenting PIs are a routine task for all bedside nurses. All nurses must document the condition and management of PIs in the EMR system. When using the app for PI management, nurses are required to photograph the ulcers, assess and document the surrounding skin condition, exudate amount, any signs of infection, and the presence of dead space. While the app supports nurses in their decision-making, they have the autonomy to use the app or traditional methods. However, nurses choosing to use the app must follow the specified guidelines.

Clinical Transformation Enabled through Information and Technology

- **Implementation**
  - Since January 2022, we have implemented a deep-learning AI-based application for PI management in the clinical setting, integrated into BPOC devices.
  - The app supports nurses in classifying PI stages and recommends the most appropriate dressing materials based on the wound condition.
  - The following image illustrates the overall concept (Fig 7). At the bedside, a nurse uses the app to take a photo of the PI, which is sent to the server. The app suggests the PI stage, and the photo along with clinical confirmation and treatment details are recorded in the EMR.

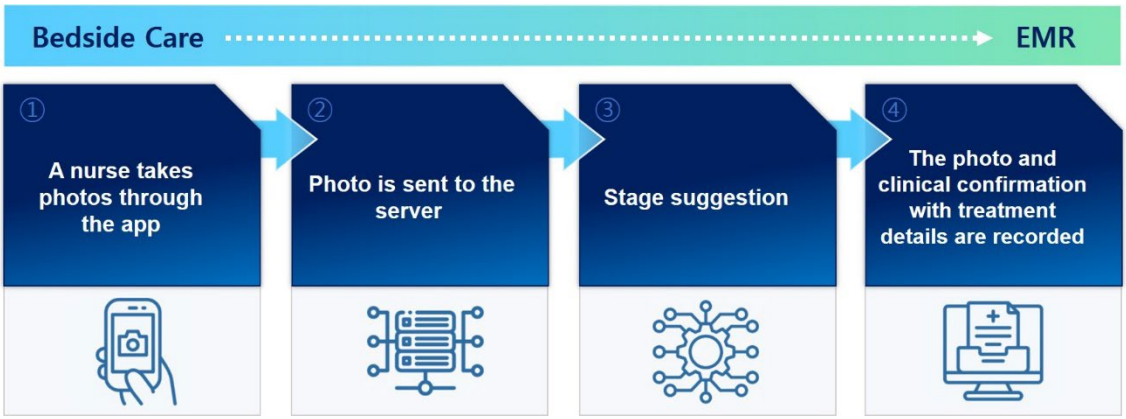

Fig 7. Overall concept of using the deep-learning AI-based application to manage PIs in a clinical nursing

- **How to Use the App** (Fig 8)

  (1) Select a patient and decide whether to use the app.
  (2) Take a photo following the box on the screen.
  (3) Input additional data to help the AI model suggest a protocol.
  (4) Check the stage suggested by the AI model. If the nurse disagrees with the classification, it can be manually changed.
  (5) The app displays a recommendation for dressing materials.
  (6) The photo and clinical confirmation with treatment details are recorded in the EMR.

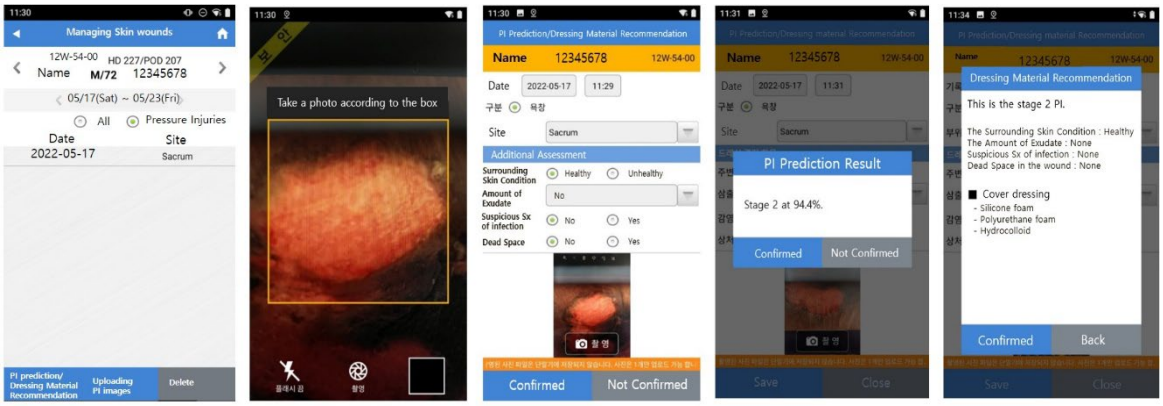

Fig 8. How to use the app for PI evaluation

- The app algorithm operates internally and is not visible when the nurse receives treatment recommendations.

Improving Adherence to the Standard of Care

- **Strategies for On-Site Integration**

  - When nurses document PIs in the EMR, other nursing team members and clinical leadership can monitor the status of the PIs through the dashboard (Fig. 9). This facilitates team-based care and promotes compliance.

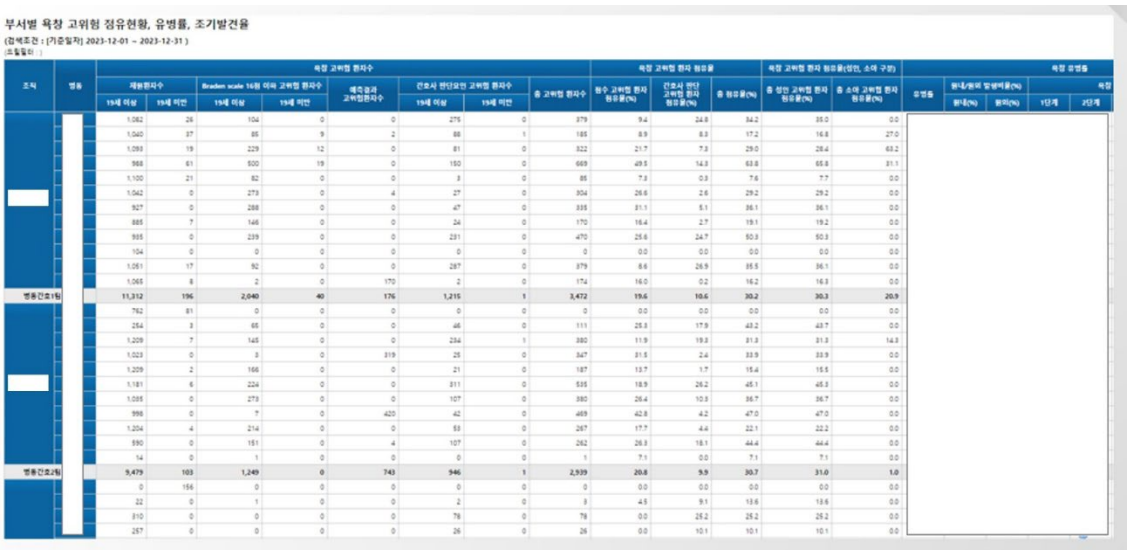

Fig 9. Dashboard for monitoring high-risk patient occupancy and PI prevalence by unit

- To enhance on-site integration, we hold PI management seminars three times a year for nurses in charge of PI care in each department. These seminars provide education on the deep-learning based app and encourage its use (Fig 10).
- Primary wound-care nurses are trained to use the app, and continuous education is provided.
- We also encourage nurse managers to create environments that support consistent app use.
- Feedback from users is collected, and necessary updates are made based on their input.

Fig 10. PI management seminar providing education on the deep-learning AI-Based application

Improving Patient Outcomes

- **Dressing Material Utilization**

  - After implementing the app in the clinical field, a comparative analysis was conducted on the types of dressing materials used for PI patients. With a p-value is less than 0.1, the analysis suggested a marginally significant difference in dressing material utilization between the App group and the Non-app group for PIs at Stage 2 and above. (Table 1).

Table 1. Types of PI dressing materials used for patients in App group and Non-App group

Subgroup	Types of dressing materials	No App use	App Use	p-value
All	open	4 (1.94%)	13 (6.47%)	0.1658
	Betadine-iodine foam	1 (0.49%)	1 (0.50%)	
	Polyurethane foam	173 (83.98%)	166 (82.59%)	
	Hydrocolloid	19 (9.22%)	14 (6.97%)	
	Hydrofiber	9 (4.37%)	7 (3.48%)	
Stage 1	open	3 (3.12%)	9 (8.41%)	0.1743
	Betadine-iodine foam	0 (0.00%)	1 (0.93%)	
	Polyurethane foam	87 (90.62%)	84 (78.50%)	
	Hydrocolloid	4 (4.17%)	8 (7.48%)	
	Hydrofiber	2 (2.08%)	5 (4.67%)	
Stage 2 and above	open	1 (0.91%)	4 (4.26%)	**0.0623**
	Betadine-iodine foam	1 (0.91%)	0 (0.00%)	
	Polyurethane foam	86 (78.18%)	82 (87.23%)	
	Hydrocolloid	15 (13.64%)	6 (6.38%)	
	Hydrofiber	7 (6.36%)	2 (2.13%)	

- **PUSH score**

  - We compared PUSH scores between the App group and the Non-app group to assess whether the app improved clinical outcomes. PI improvement was assessed by changes in PUSH scores between the initial evaluation and a seven-day follow-up. A chi-square test determined the statistical differences ($P<0.05$).

  - Various scales, including the PUSH and the Bates-Jensen Wound Assessment Tool (BWAT) are widely used to assess PI healing. These tools are essential for evaluating the effectiveness of PI-prevention and intervention methods implemented by nurses, who must monitor changes in patients' PIs. The PUSH tool was utilized to evaluate PI status over time. A decrease in the PUSH score indicates improvement (Table 2).

Table 2. The Pressure Ulcer Scale for Healing (PUSH) Tool

LENGTH X WIDTH (in cm^2)	0 0	1 < 0.3	2 0.3 - 0.6	3 0.7 - 1.0	4 1.1 - 2.0	5 2.1 - 3.0	Sub-score
		6 3.1 - 4.0	7 4.1 - 8.0	8 8.1 - 12.0	9 12.1 - 24.0	10 > 24.0	
EXUDATE AMOUNT	0 None	1 Light	2 Moderate	3 Heavy			Sub-score
TISSUE TYPE	0 Closed	1 Epithelial Tissue	2 Granulation Tissue	3 Slough	4 Necrotic Tissue		Sub-score
							Total Score

- The study included patients aged 40 and older with PIs who were hospitalized for 180 days or less between January 1, 2022, and May 23, 2024. Cases without recorded PUSH scores within 4 to 10 days were excluded. Cases were divided into the App group (N=305) and the Non-app group (N=8,060) based on app usage.

- To ensure comparability, propensity score matching (PSM) was applied at a 1:1 ratio. Nearest-neighbor matching was used to select individuals in the Non-app group most similar to those in the App group. After matching, the final analysis included 610 cases (305 in each group). Matching took into account age, sex, PI stage, base PUSH score, and unit to account for differences in PI characteristics, healing processes, and nursing care quality. The two cohorts were well balanced after matching (Fig 11). Table 3 shows the balance, with most standardized mean differences (SMD) being less than 0.1.

Table 3. Results of propensity score matching of App group and the Non-App group.

		Before Matching (N=8365)			After 1:1 PS Matching (N=610)		
		Means Treated	Means Control	Absolute value of Std. Mean Diff.	Means Treated	Means Control	Std. Mean Diff.
age	40대	0.0328	0.0628	0.1684	0.0328	0.0361	0.0184
	50대	0.1443	0.1289	0.0437	0.1443	0.1279	0.0467
	60대	0.2361	0.2969	0.1432	0.2361	0.2525	0.0386
	70대	0.3344	0.3017	0.0693	0.3344	0.3344	0
	80대이상	0.2525	0.2097	0.0985	0.2525	0.2492	0.0075
sex	F	0.3738	0.3391	0.0717	0.3738	0.3672	0.0136
	M	0.6262	0.6609	0.0717	0.6262	0.6328	0.0136
baseline_BedScoreStage1	1단계	0.4557	0.3859	0.1403	0.4557	0.4656	0.0197
	2단계	0.2492	0.338	0.2053	0.2492	0.2459	0.0076
	3단계	0.0459	0.0288	0.0818	0.0459	0.0492	0.0157
	4단계	0.0164	0.0025	0.1096	0.0164	0.0098	0.0516
	미분류	0.0951	0.0883	0.023	0.0951	0.0918	0.0112
	심부조직손상	0.1377	0.1566	0.0548	0.1377	0.1377	0
baseline_recordedWard	02M	0.0066	0.0465	0.4952	0.0066	0.0098	0.0406
	03C	0.0066	0.0422	0.4414	0.0066	0.0033	0.0406
	03H	0.0131	0.0159	0.0243	0.0131	0.0131	0
	03N	0.0098	0.0058	0.0406	0.0098	0.0098	0
	03PH	0.0066	0.0029	0.0459	0.0066	0.0098	0.0406
	03S	0.0098	0.0086	0.0129	0.0098	0.0098	0
	05E	0.0066	0.017	0.1294	0.0066	0.0098	0.0406
	08W	0.0033	0.0048	0.0273	0.0033	0.0033	0
	10E	0.0164	0.0153	0.0089	0.0164	0.0164	0
	10W	0.0066	0.0066	0.0002	0.0066	0.0033	0.0406
	11E	0.0098	0.216	2.0891	0.0098	0.0098	0
	12W	0.0033	0.0011	0.0378	0.0033	0	0.0574
	13E	0.0098	0.0089	0.0092	0.0098	0.0033	0.0664
	13W	0.0164	0.0164	0.0001	0.0164	0.0164	0
	14W	0.0066	0.0022	0.0536	0.0066	0.0066	0
	15E	0.0033	0.0094	0.1076	0.0033	0.0098	0.1147
	15W	0.0098	0.0365	0.2699	0.0098	0.0066	0.0332
	16E	0.0066	0.0154	0.1094	0.0066	0.0033	0.0406
	16W	0.0164	0.033	0.1308	0.0164	0.0098	0.0516
	17E	0.4951	0.0706	0.849	0.4951	0.5148	0.0393
	17W	0.0098	0.0042	0.0569	0.0098	0.0066	0.0332
	18E	0.0033	0.004	0.0121	0.0033	0.0033	0
	18W	0.0131	0.0212	0.0712	0.0131	0.0098	0.0288
	19S	0.0033	0.0208	0.3073	0.0033	0.0033	0
	C03M	0.1082	0.0299	0.2521	0.1082	0.0885	0.0633
	C03S	0.0885	0.0164	0.254	0.0885	0.0984	0.0346
	C06E	0.0033	0.0097	0.1119	0.0033	0	0.0574
	C06W	0.0098	0.0074	0.0242	0.0098	0.0066	0.0332
	C07E	0.0098	0.0037	0.062	0.0098	0.0131	0.0332
	C07W	0.0131	0.0118	0.0117	0.0131	0.0197	0.0576
	C08E	0.0033	0.0208	0.3073	0.0033	0	0.0574
	C08W	0.0164	0.0092	0.0568	0.0164	0.0131	0.0258
	C09E	0.0033	0.0041	0.0143	0.0033	0.0033	0
	C09W	0.0033	0.0056	0.0403	0.0033	0	0.0574
	C10E	0.0197	0.0378	0.1308	0.0197	0.0262	0.0472
	C10W	0.0197	0.0718	0.3756	0.0197	0.0328	0.0944
	C11E	0.0033	0.0249	0.3789	0.0033	0.0033	0
	C11W	0.0066	0.0094	0.0356	0.0066	0.0033	0.0406
baseline_pushscore		6.4295	5.8491	0.1508	6.4295	6.5967	0.0434

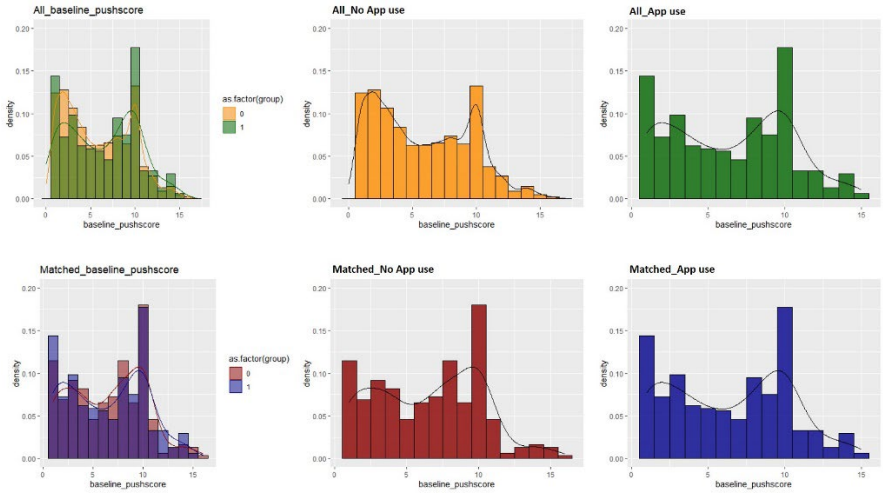

Fig 11. This chart illustrates the distribution of PUSH scores between the App group and the Non-app group before and after applying propensity score matching (PSM).

- PIs were classified into six stages. Since Stage 1 PIs are milder and more frequent, we conducted a stratified analysis based on PI stages (Stage 1 vs. Stage 2 and above) to avoid skewed data.
- The App group showed a better improvement rate for Stage 2 and above (48.80% vs. 35.58%, P=0.015), with a 37% better healing rate compared to the Non-app group (Fig 12).
- However, for Stage 1 PIs, there was no significant difference in improvement rates between the App and Non-app groups (8.63% vs. 15.49%, P=0.078) (Table 4).

Table 4. PI improvement rate comparison after 1:1 PSM [App group (N=305) and Non-app group (N=305)]

Subgroup			No App use (N=305)	App use (N=305)	p-value
All (N=610)		Improved	80 (26.23%)	93 (30.49%)	0.243
		Non-improved	225 (73.77%)	212 (69.51%)	
	Stage 1	Improved	22 (15.49%)	12 (8.63%)	0.078
		Non-improved	120 (84.51%)	127 (91.37%)	
	Stage 2 and above	Improved	58 (35.58%)	81 (48.80%)	**0.015**
		Non-improved	105 (64.42%)	85 (51.20%)	

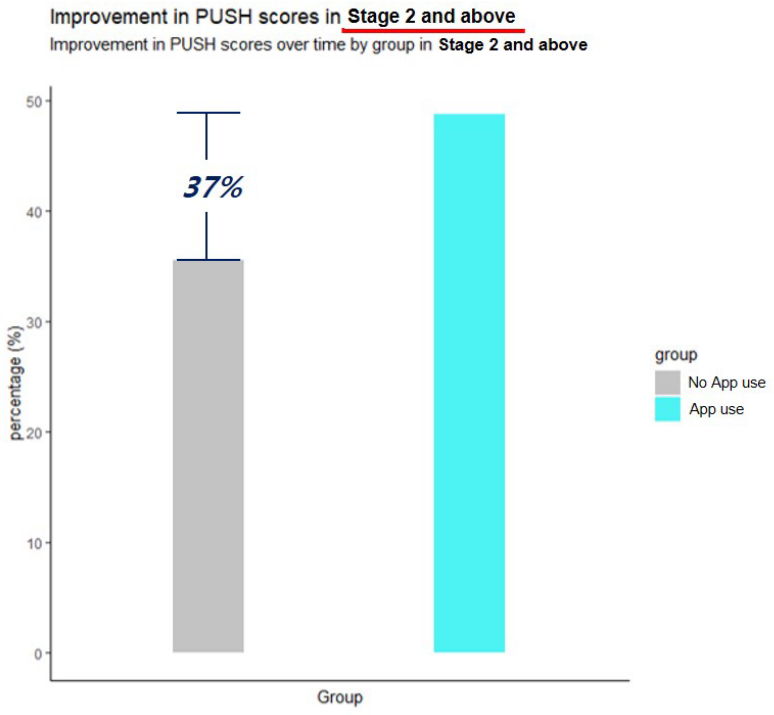

Fig 12. After 1:1 PSM [App group (N=305) and Non-app group (N=305)], the App group continued to exhibit a better improvement rate for PIs of Stage 2 and above (48.80% vs. 35.58%, P=0.015).

- The following graph shows annual improvement rates in PUSH scores by group from 2022 to mid-2024. It confirms that the App group consistently shows better improvement rates for PIs at Stage 2 and above (Fig 13).

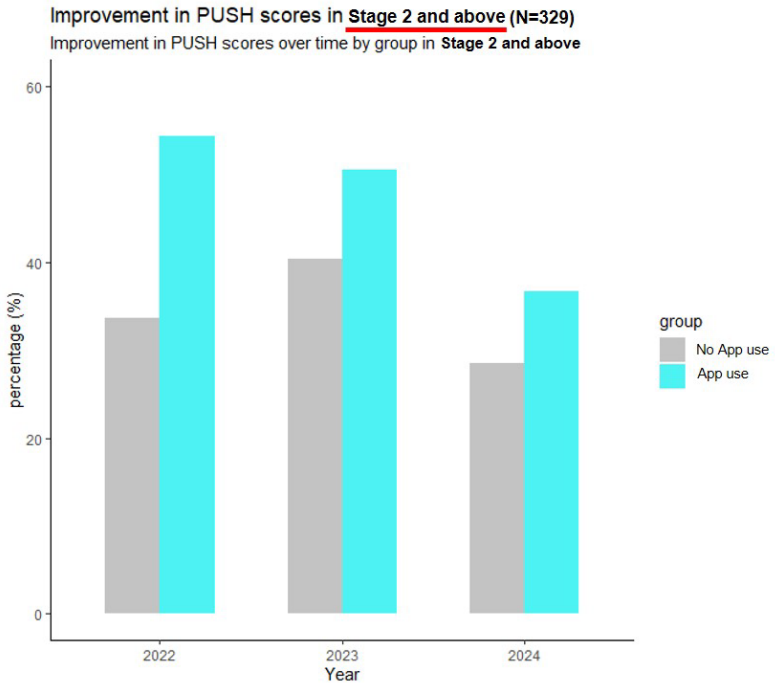

Fig 13. Annual improvement rates in PUSH scores by group from 2022 to mid-2024 (Due to the very low number of monthly PI occurrences, the improvement rates of PIs were presented annually. For the year 2024, only data for January to May is included.)

- **Subgroup Analysis**

  - While investigating the length of stay as an outcome, we identified a subgroup of patients who initially managed PIs without the app but started using it midway (Fig 14).

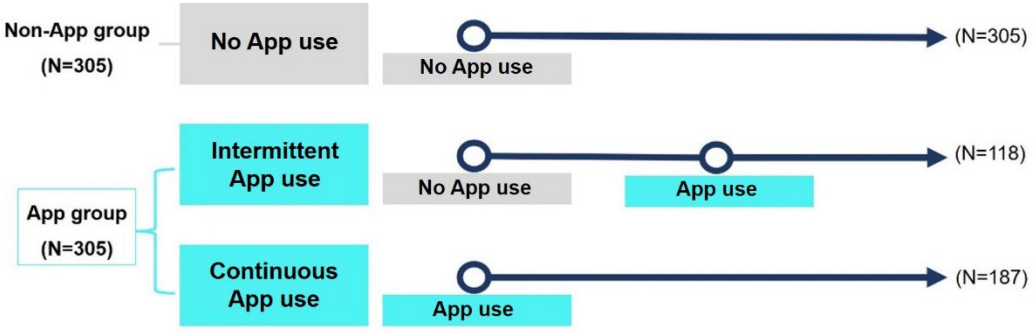

Fig 14. Subgroup Analysis

- Subgroup analysis was conducted in the intermittent App use group and also in the continuous App use group, resulting in 187 cases per group. We compared the PI improvement rates for Stage 2 and above PI(subjects for reporting to the nurse manager) of the App use compared to pre-matched with No App use cases, resulting in 166 cases of the intermittent App group and 88 cases of the continuous App group.

- In cases of PIs at Stage 2 and above, the healing rate was 37% higher in the App group than in the intermittent and Non-app groups combined. However, when comparing only continuous app users with the Non-app group, the healing rate was 40% higher (51.14% vs. 36.46%, P=0.045) (Table 5, Fig 15).

Table 5. PI improvement rate [App group (continuous app use) vs. Non-app group)

		No App use	Intermittent App Use	p-value
Stage 2 and above	Improved	58 (35.58%)	81 (48.80%)	0.015
	Non-improved	105 (64.42%)	85 (51.20%)	

		No App use	Continuous App Use	p-value
Stage 2 and above	Improved	35 (36.46%)	45 (51.14%)	0.045
	Non-improved	61 (63.54%)	43 (48.86%)	

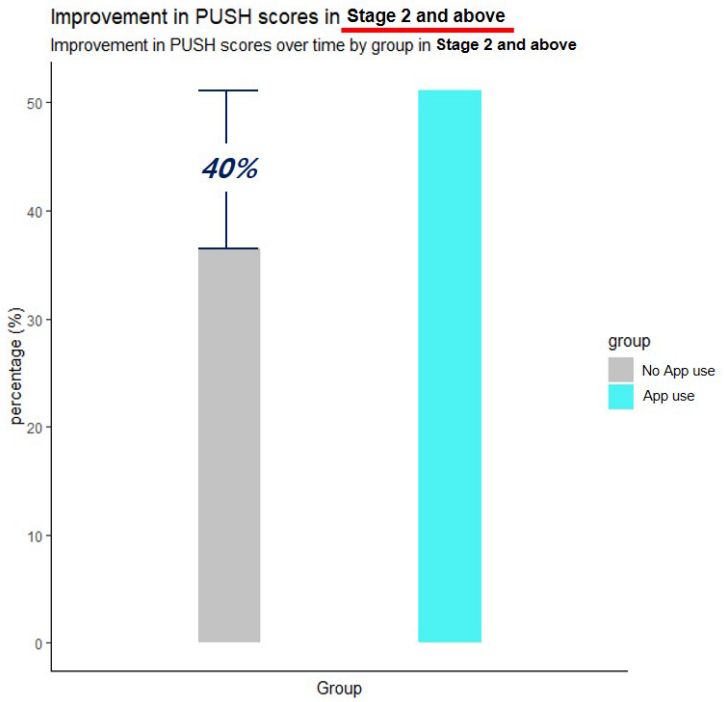

Fig 15. PUSH score improvement in continuous app users vs. Non-app group. The App group had a healing rate 40% higher (51.14% vs. 36.46%, P=0.045).

- **Length of Stay**

  - We conducted a comparative analysis of length of stay, but no significant difference was observed between the App and Non-app groups.
  - Reanalysis will be necessary in the future when more users adopt the app. Further studies will be required to understand the app's impact on the length of stay.

Accountability and Driving Resilient Care Redesign

- **Changes in Care Delivery**

  - App use requires nurses to assess and document the condition of the surrounding skin, exudate amount, infection symptoms, and dead space. As a result, PI records generated through the app are more comprehensive than those created without the app.

  - The PI stage was originally determined based on each nurse's knowledge and experience, but now the app assists nurses to make an appropriate decision regardless their capabilities.

  - Without the app, nurses had to remember the details of the PIs they had assessed until documentation was completed. With the app, assessment and documentation occur simultaneously, allowing nurses to focus more on care delivery.

- **Feedback from End Users**

  Below are examples of feedback received from nurses:

  "It assists in determining the stage of PIs and offers high accuracy."

  "It has enabled me to compare the results from the PI app with my own decisions."

  "Newly hired nurses, who may not be well-versed in PI management, are highly satisfied with the app due to its ease of use."

  "It would be even better if we could take and document multiple PI images at once."

  - While most feedback was positive, users suggested adding a feature to photograph and document multiple PIs simultaneously.

- **Utilization Rate**

  - The following chart shows app usage trends by quarter (Fig 16).

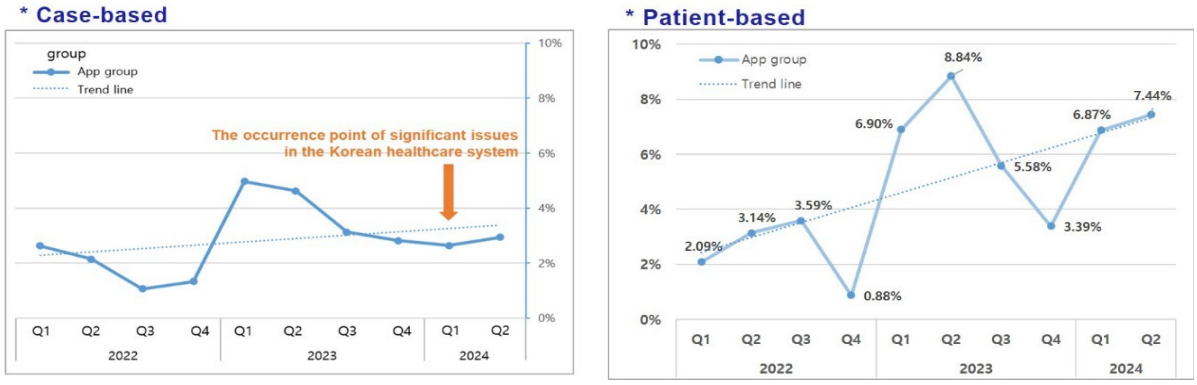

Fig 16. Quarterly trends in app usage. Shifting the analysis from case-based to patient-based reveals higher app usage rates.

  - This app is a tool to support clinical decision-making, and its use is not mandatory. App usage started at around 4% when introduced in January 2022 and gradually increased until the doctors' workforce crisis in South Korea in February 2024.

  - Due to the physician shortage, nurses at Samsung Medical Center have taken on additional tasks, leading to a reduction in workforce available for traditional nursing duties. While the bed occupancy rate has dropped, the proportion of critically ill patients has remained constant or increased slightly, raising nurses' workloads. Consequently, PI management and app usage have temporarily declined. However, we anticipate a recovery in usage as the workforce crisis resolves.

- **For a More Effective Tool and Adoption**

  - Multiple Lesions

    - We plan to modify the app to allow nurses to capture and document multiple PI sites simultaneously, based on user feedback.

  - Upgrading AI Performance

    - We are planning to enhance the app's diagnostic accuracy by leveraging accumulated data and updating the algorithm, in conjunction with changes to the International Pressure Injury Guideline.

  - Prognosis

    - The app will be developed to predict the likelihood of PI healing using data from previous cases, including factors such as surrounding skin condition, exudate among, infection signs, and dead space.

- Although the app is optional, we believe that incorporating user-requested features like the ability to document multiple PIs at once, as well as prognostic capabilities, will significantly increase adoption among nurses.

- **Successful Strategies**

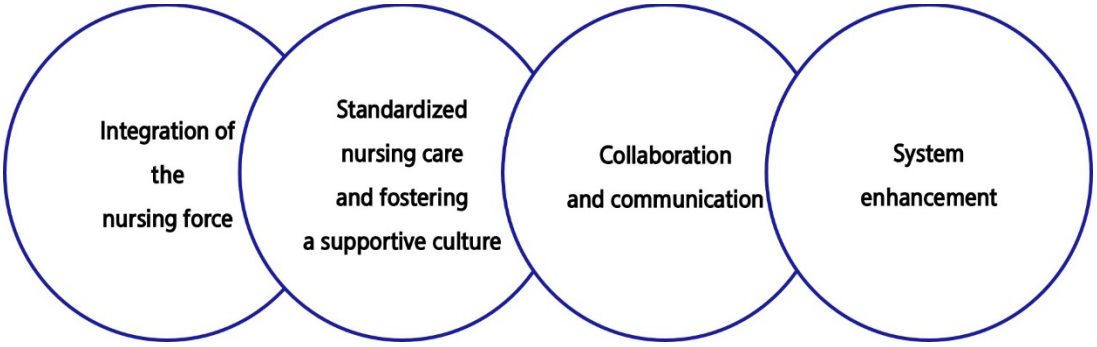

Fig 17. Major components of successful strategies

- Successful integration of new AI technologies, such as this app, into nursing practice requires thorough preliminary research to ensure that technology does not disrupt existing workflows or priorities.

- We ensured that nurses could perform their tasks with minimal disruption by integrating the app into the existing BPOC system, which requires no additional devices. This app minimized interference with nursing workflow and facilitated a smooth adoption.

- Since accurate PI staging and appropriate dressing selection are key to effective PI management, we included a decision-support feature to guide nurses in choosing dressings based on ulcer conditions. Unlike other systems, this app fully integrates the WOCN guidelines, ensuring patients receive the most suitable care, which is expected to improve healing rates.

- This deep-learning based app for PI management is the first case of its kind to be incorporated into a BPOC system. While AI technologies are being explored in various hospitals, many remain in development or testing phases. Successful implementation requires collaboration among experts, strong leadership, and a culture that embraces change.

HIMSS Global Conference Audience Guidance (This will not be published)

Topic Guidance: Check three which apply to this case study

Clinical Informatics and Clinician Engagement

Improving Quality Outcomes

Process Improvement, Workflow, and Change Management

User-Centered Design