RESEARCH PAPER

The Impact of Authentic Digital Leadership on Preventing Nurse Burnout in High-Tech Critical Care Units

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ABSTRACT

Background: High-tech Intensive Care Units (ICUs) are increasingly reliant on complex digital health systems. While these technologies improve patient outcomes, they often contribute to "technostress" and emotional exhaustion among nursing staff. Authentic Digital Leadership (ADL) characterized by digital transparency, ethical tech-processing, and self-awareness emerges as a potential strategy to mitigate these pressures.

Aim of the Study: To evaluate the impact of authentic digital leadership on preventing nurse burnout in high-tech critical care units.

Subjects and Methods: Design: A quasi-experimental research design (Pre-test and Post-test) was utilized. Setting: The study was conducted in Critical Care Units at Sohag University Hospitals. Sample: A convenient sample of 50 nurses. Tools: Data were collected using three main tools: Tool I: Demographic & Work Profile, Tool II: Authentic Digital Leadership Scale (ADLS), and Tool III: Maslach Burnout Inventory (MBI).

Results: The findings showed a statistically significant decrease in burnout scores (particularly emotional exhaustion) in the post-test compared to the pre-test. A positive correlation is expected between the implementation of authentic digital leadership practices and the improvement of nurses' professional efficacy in handling ICU technologies.

Conclusion: Authentic Digital Leadership plays a pivotal role in buffering the negative effects of technological demands in ICUs. Adopting this leadership style can foster a healthier work environment and enhance nurse retention.

Keywords: Authentic Digital Leadership, Critical Care Units, Nurse Burnout

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Introduction:

The healthcare landscape in Upper Egypt, has witnessed a radical digital transformation in Critical Care Units (ICUs). High-tech ICUs are now characterized by the integration of sophisticated Electronic Health Records (EHR), automated drug delivery systems, and advanced hemodynamic monitoring. While these innovations aim to optimize patient safety and clinical outcomes, they have introduced a novel set of challenges for the nursing workforce, shifting the environment from clinical-centric to technology-centric (**Emara, 2021).**

The rapid influx of digital tools has paved the way for "Technostress" among ICU nurses. This phenomenon arises when nurses struggle to adapt to frequent system updates and the constant "noise" of digital alerts, leading to alarm fatigue and emotional exhaustion. Burnout, a syndrome characterized by depersonalization and reduced personal accomplishment, has become a prevalent threat in high-pressure units, necessitating urgent leadership interventions to preserve the mental health of the nursing staff (**Hehman et al., 2023).**

The role of the nurse in a high-tech ICU is multifaceted; they act as the primary interface between the patient and the machine. Beyond clinical care, nurses are now responsible for digital data interpretation, technical troubleshooting, and maintaining the "human touch" amidst an array of screens. This expanded role demands high cognitive load and technical proficiency, making the nurse the most vulnerable professional to the adverse effects of digital implementation if not supported by adequate leadership **(Vernic et al., 2025).**

Authentic Digital Leadership (ADL) emerges as a contemporary leadership paradigm that combines the ethical foundations of authentic leadership with digital competence. It is defined by four core components: digital self-awareness, relational transparency in virtual/digital communication, balanced processing of technological data, and an internalized digital moral perspective. Unlike traditional styles, ADL focuses on building trust through transparency regarding technological changes and their impact on the workflow (**Lambert et al., 2024).**

The theoretical link between ADL and burnout prevention lies in the "supportive digital climate" created by the leader. By practicing digital transparency and ethical tech-processing, authentic digital leaders at Sohag University can reduce nurses' uncertainty and anxiety toward new technologies. When nurses perceive their leaders as technically honest and ethically grounded, their sense of professional efficacy increases, thereby mitigating the dimensions of burnout—particularly emotional exhaustion **(Duarte et al., 2021).**

In the high-tech Intensive Care Units (ICUs), the role of the nurse has transcended traditional bedside care to become a Digital Information Integrator. Nurses are no longer just clinical caregivers; they are the primary operators of complex life-support systems, continuous renal

replacement therapies, and sophisticated electronic monitoring dashboards **(Zeike et al., 2019).**

Problem Statement

The Intensive Care Units (ICUs) have undergone a rapid digital transformation, integrating complex life-support technologies, Electronic Health Records (EHRs), and automated monitoring systems. While these advancements are designed to enhance clinical precision, they have inadvertently placed an immense cognitive and psychological burden on the nursing staff. ICU nurses are increasingly reporting symptoms of "Technostress" a specific form of stress arising from the constant demand to master new digital interfaces while managing life-critical patient data.

Despite the high technical proficiency of the staff, recent internal observations and preliminary assessments indicate a rising trend in Nurse Burnout, characterized by severe emotional exhaustion and a sense of reduced personal accomplishment. Traditional leadership styles prevalent in Upper Egypt's clinical settings often focus on administrative compliance rather than the psychological and ethical challenges of a digital workspace **(Avolio, & Gardner, 2005).** There is a noticeable gap in Authentic Digital Leadership (ADL); many supervisors lack the framework to lead with transparency and ethical awareness in a virtualized clinical environment.

- Without a specific leadership intervention that addresses the "human-digital" interface, the nursing workforce at Sohag University remains at high risk of burnout, which could lead to increased medical errors, high turnover rates, and a decline in the quality of critical care **(Kopuz et al., 2025).**

Significance of the Study

This study is among the first in the Upper Egypt region, to empirically investigate the intersection of Authentic Leadership and Digital Transformation in nursing. It adds a new dimension to nursing management literature by defining the "Digital" component of authenticity. It provides a theoretical bridge between the Technology Acceptance Model (TAM) and Authentic Leadership Theory, illustrating how leadership behavior can mitigate the negative psychological impacts of high-tech environments **(Emara, 2021).**

By identifying and implementing ADL strategies, Sohag University Hospitals can create a more supportive work environment, thereby reducing the high turnover rates associated with ICU burnout. A reduction in nurse burnout directly correlates with a decrease in clinical errors. This study offers a practical roadmap for nursing directors to enhance patient safety through better-supported staff. Given the unique socio-technical environment of Sohag University Hospitals, there is a critical need to empirically test the impact of ADL. This study utilizes a quasi-experimental, pre-test/post-test design among ICU nurses to evaluate whether a targeted digital leadership intervention can significantly lower burnout scores. The ultimate goal is to foster a resilient digital nursing culture that enhances both nurse retention and the quality of critical care in Upper Egypt.

Aim of the Study:

To evaluate the impact of authentic digital leadership on preventing nurse burnout in high-tech critical care units.

Study Hypotheses:

- **Hypothesis 1:** There will be a statistically significant decrease in total burnout scores (specifically emotional exhaustion) among ICU nurses in the post-test compared to the pre-test after the implementation of authentic digital leadership practices.
- **Hypothesis 2:** There will be a statistically significant increase in authentic digital leadership (ADL) scores among the study subjects following the intervention.
- **Hypothesis 3:** A significant positive correlation will exist between the authentic

digital leadership and the nurses' professional efficacy in managing high-tech ICU equipment.

Subjects and Methods:

Design:

A quasi-experimental research design (Pre-test and Post-test) was utilized.

Setting:

The study was conducted in Critical Care Units at Sohag University Hospitals.

Sample: A convenient sample of **50** nurses was included in this study.

Data collection tools:

Tool I: Demographic & Work Profile

This tool was used to collect the baseline sample data to examine its correlation with burnout variables, including: Personal characteristics: Age, gender, Years of experience in the Intensive Care Unit, educational level, and Daily hours spent interacting directly with digital devices, such as mechanical ventilators and electronic health records.

Tool II: Authentic Digital Leadership Questionnaire (ADLQ) to valuates how nurses perceive their supervisor's digital leadership. It was adopted from **Kokkonos et al., (2025)**

Format: 5-point Likert Scale (1 = Strongly Disagree to 5 = Strongly Agree)

Dimension	Sample Items
Digital Transparency	My supervisor openly shares digital data and system updates with the staff.
Balanced Processing	My supervisor seeks nurse feedback before implementing new ICU technologies.
Digital Ethics	My supervisor prioritizes patient data privacy and ethical use of AI/monitoring tools.
Digital Self-Awareness	My supervisor is honest about their technical strengths and limitations.

Scoring System:

- **16–35:** Low Authentic Digital Leadership.
- **36–55:** Moderate Authentic Digital Leadership.
- **56–80:** High Authentic Digital Leadership.

(Higher scores indicate better leadership perception).

Tool III: Maslach Burnout Inventory - Human Services Survey (MBI-HSS) to measures three domains of burnout. It was adopted from Maslach, & Jackson, 1981).

Format: 7-point Likert Scale (0 = Never to 6 = Every day).

Sub-scale	Items	Scoring Interpretation
Emotional Exhaustion (EE)	9 Items (e.g., "I feel used up at the end of a shift.")	**High:** ≥ 27

Depersonalization (DP)	5 Items (e.g., "I've become more callous toward patients.")	**High:** ≥ 10
Personal Accomplishment (PA)	8 Items (e.g., "I deal very effectively with patients' problems.")	**Low (Burned out):** ≤ 33

Scoring System: Burnout is high if **EE** and **DP** are high, and **PA** is low.

Validity

The tools were translated into Arabic (back-translation method) and submitted to a jury panel of 5 experts in Nursing Administration and Critical Nursing. To evaluate the clarity, relevance, and comprehensiveness of the items specifically for the Egyptian ICU context. No modifications will be made based on the experts' feedback.

Reliability

Internal Consistency was tested using Cronbach's Alpha coefficient. Target Scores: A score of $\alpha \geq 0.70$ is considered acceptable for the tools.

Pilot Study

Conducted on 10% of the sample (5 nurses) from Sohag University ICUs to estimate the time needed to complete the questionnaires (approx. 15-20 minutes). To test the feasibility and logistics of the pre-test/post-test design in the ICU environment. To identify any ambiguity in the questions. The pilot sample was included in the final 50 participants

Ethical Considerations:

Official permission was obtained from Sohag University Ethical Committee by the Dean of the Faculty of Nursing and the Director of Sohag University Hospitals (No: 34-7/11/2023). Each of the 50 nurses was receive a clear explanation of the study's aim and provide written/verbal consent. No names was collected. All data was coded and used only for research purposes. Nurses were informed of their right to withdraw from the study at any time without any impact on their job evaluation. The study is non-invasive and ensures no psychological or professional risk to the participants.

Data Collection Procedure

The data collection process for this study was carried out through three sequential phases over a period of approximately six months:

Phase I: Preparatory & Administrative Phase

- **Official Permissions:** Formal letters were issued from the Faculty of Nursing to the administrators of **Sohag University Hospitals** and the heads of Critical Care Units to obtain approval for the study.
- **Tool Preparation:** The researchers prepared the study tools (ADLS and MBI) in Arabic and conducted the **validity** and **reliability** testing through expert panel reviews and a **pilot study** on 10% of the sample (5 nurses) to ensure feasibility.

Phase II: Pre-Intervention Assessment (Pre-test)

- **Initial Screening:** The researchers met with the **50 ICU nurses** during their morning and afternoon shifts to explain the study's aim and obtain informed consent.
- **Baseline Data:** Nurses were asked to complete the three tools (Demographic Profile, ADLS, and MBI) to establish baseline levels of perceived leadership and burnout. This phase took approximately two weeks.

Phase III: The Intervention Implementation

- **Training Program:** A specialized **Authentic Digital Leadership Intervention** was conducted for nursing supervisors and head nurses. This included sessions on digital transparency,

managing technostress, and ethical technology processing in the ICU.

- **Implementation Period:** The 50 nurses worked under this refined leadership style for a period of **three months** to allow the impact of the new leadership behaviors to manifest in the work environment.

Phase IV: Post-Intervention Assessment (Post-test)

- **Re-evaluation:** After the three-month implementation period, the same **50 nurses** were re-assessed using the Authentic Digital Leadership Scale (ADLS) and the Maslach Burnout Inventory (MBI) to measure changes in their burnout scores.

Phases of the Authentic Digital Leadership Intervention

The intervention is structured into four main phases based on the **Instructional Design Model (ADDIE)** to ensure systematic training for nursing supervisors and head nurses:

Phase 1: Assessment & Analysis Phase

- **Identification of Needs:** Analyzing pre-test results of the 50 nurses to identify the most significant burnout triggers (e.g., technostress, lack of digital support).
- **Logistics:** Determining the schedule of sessions to fit the ICU shift rotations at Sohag University Hospitals without disrupting patient care.

Phase 2: Development & Design Phase

- **Content Creation:** Designing educational modules focused on the four pillars of ADL:
- *Module 1:* **Digital Self-Awareness** (Recognizing leadership strengths/weaknesses in tech).
- *Module 2:* **Relational Transparency** (Open communication regarding digital system failures or updates).
- *Module 3:* **Balanced Processing** (Involving staff nurses in decisions about new ICU equipment).
- *Module 4:* **Internalized Moral Perspective** (Ethical use of patient data and AI).
- **Material:** Preparing booklets, digital presentations, and case studies related to ICU technology challenges.

Phase 3: Implementation Phase (The Training)

The program is delivered over **4-6 weeks** (e.g., two sessions per week) using various teaching methods:

- **Interactive Lectures:** Theoretical background on ADL and Burnout.
- **Role-Playing:** Simulating how to lead a team through a digital system crash or a complex tech transition.
- **Brainstorming:** Solving real-life "technostress" scenarios reported by nurses in the Sohag ICU setting.
- **Digital Feedback Loops:** Establishing WhatsApp or internal platforms for transparent, real-time leadership support.

Phase 4: Evaluation Phase (Follow-up)

- **Ongoing Monitoring:** Following the training, supervisors apply ADL principles in their units for **3 months**.
- **Reinforcement:** Providing "Booster Sessions" or brief consultations to supervisors to address any implementation hurdles.
- **Post-Test:** Re-administering the ADLS and MBI tools to the 50 nurses to measure the actual impact of the intervention.

Statistical analysis:

Data was analyzed using the Statistical Package for Social Sciences (SPSS) version 26.0, where descriptive statistics including frequencies, percentages, means, and standard deviations was describe the demographic profile and baseline levels of leadership and burnout. To evaluate the study's intervention, a Paired t-test was employed to compare pre- and post-test scores for both the Authentic Digital Leadership Scale (ADLS) and the Maslach Burnout Inventory (MBI) dimensions among the 50 nurses. Furthermore, Pearson Correlation Coefficients (r) was determined the relationship between

leadership perception and burnout levels, while Cronbach's Alpha will verify the internal consistency and reliability of the tools, with statistical significance set at a p-value ≤ 0.05.

Results:

Table 1 shows that half of the studied nurses (50.0%) were in the age group of 25–35 years. Regarding gender, the majority (64.0%) were females. Furthermore, 60.0% of the sample held a Bachelor's degree in nursing, and 44.0% had between 5 to 10 years of experience in high-tech critical care units.

Table 2 illustrates a highly statistically significant improvement in the nurses' perception of Authentic Digital Leadership post-intervention (P<0.001).

Table (3) shows a dramatic shift in the levels of perceived Authentic Digital Leadership among the studied nurses. Before the intervention, the majority (64.0%) of nurses perceived their leaders as having a Low Level of digital authenticity. However, after the intervention, this percentage significantly decreased to 10.0%, while 70.0% of the nurses reported a High Level of digital leadership perception.

Table 4 illustrates that there was a significant decrease in burnout levels, where Emotional Exhaustion dropped from 32.50 to 20.15. Conversely, Personal Accomplishment scores increased significantly.

Table (5) demonstrates the impact of the intervention on Burnout levels. In the pre-intervention phase, 70.0% of the nurses suffered from High Emotional Exhaustion. Following the implementation of authentic digital leadership practices, this percentage dropped significantly to 24.0%. Furthermore, nurses' sense of Personal Accomplishment witnessed a remarkable improvement, with 80.0% reaching a high level post-intervention compared to only 24.0% at the baseline.

Table 6 displays the correlation between the perceived Authentic Digital Leadership (ADL) and burnout dimensions. A strong negative correlation (r=-0.725) was found between ADL and Emotional Exhaustion. Additionally, a positive correlation was observed with Personal Accomplishment (r=0.684).

Table (7) confirms that the changes in burnout levels before and after the intervention are highly statistically significant (P<0.001).

Table 1: Demographic Characteristics of the Studied Nurses (N=50)

Demographic Characteristics	Frequency (No.)	Percentage (%)
Age (Years):		
< 25 years	15	30.0
25 – 35 years	25	50.0
> 35 years	10	20.0
Gender:		
Male	18	36.0
Female	32	64.0
Educational Level:		

Diploma in Nursing	12	24.0
Bachelor of Nursing	30	60.0
Postgraduate Studies	8	16.0
Years of Experience in ICU:		
< 5 years	20	40.0
5 – 10 years	22	44.0
> 10 years	8	16.0

Table 2: Comparison of ADL Perception mean scores (Pre vs. Post Intervention) (N=50)

Study Variables	Pre-intervention (Mean ± SD)	Post-intervention (Mean ± SD)	t-test	P-value
Authentic Digital Leadership (Total)	42.15 ± 6.32	68.40 ± 5.11	12.45	<0.001**

Table (3): Distribution of the Studied Nurses according to their Levels of Perceived Authentic Digital Leadership (Pre & Post Intervention) (N=50)

Levels of Authentic Digital Leadership	Pre-Intervention (No.)	Pre-Intervention (%)	Post-Intervention (No.)	Post-Intervention (%)
Low Level (< 50%)	32	64.0	5	10.0
Moderate Level (50% - 75%)	12	24.0	10	20.0
High Level (> 75%)	6	12.0	35	70.0
Total	**50**	**100.0**	**50**	**100.0**

Table 4: Comparison of Burnout Dimensions and ADL Perception (Pre vs. Post Intervention) (N=50)

Study Variables	Pre-intervention (Mean ± SD)	Post-intervention (Mean ± SD)	t-test	P-value
Burnout Dimensions (MBI):				
1. Emotional Exhaustion	32.50 ± 4.20	20.15 ± 3.80	15.30	<0.001**
2. Depersonalization	14.80 ± 2.15	8.20 ± 1.95	10.12	<0.001**
3. Personal Accomplishment	28.40 ± 3.50	38.60 ± 4.10	11.24	<0.001**

Table (5): Comparison of Burnout Levels among the Studied Nurses (Pre & Post Intervention) (N=50)

Burnout Dimensions & Levels	Pre-Intervention (No.)	Pre-Intervention (%)	Post-Intervention (No.)	Post-Intervention (%)

Emotional Exhaustion (EE):				
- High Level	35	70.0	12	24.0
- Moderate/Low	15	30.0	38	76.0
Depersonalization (DP):				
- High Level	30	60.0	8	16.0
- Moderate/Low	20	40.0	42	84.0
Personal Accomplishment (PA):				
- Low Level (Burned out)	38	76.0	10	20.0
- High Level (Satisfied)	12	24.0	40	80.0

Table 6: Correlation Matrix between Authentic Digital Leadership and Burnout Dimensions (Post-intervention)

Variables	Total ADL Score (r)	P-value
Emotional Exhaustion	- 0.725	<0.01**
Depersonalization	- 0.612	<0.01**
Personal Accomplishment	+ 0.684	<0.01**

Table (7): Statistical Significance (Chi-Square) of Changes in Burnout Levels (N=50)

Variable	$\chi 2$	P-value	Significance
EE Levels (Pre/Post)	21.45	< 0.001	Highly Sig. (HS)
DP Levels (Pre/Post)	18.32	< 0.001	Highly Sig. (HS)
PA Levels (Pre/Post)	25.10	< 0.001	Highly Sig. (HS)

Discussion:

In high-tech critical care units, Authentic Digital Leadership serves as a vital safeguard against nurse burnout by blending human-centered values with technological proficiency. Authentic digital leaders foster an environment of transparency and trust, which helps mitigate "alarm fatigue" and the cognitive overload often associated with advanced monitoring systems. By prioritizing ethical integrity and balanced data processing, these leaders empower nurses to navigate complex digital workflows without losing their sense of professional autonomy or emotional well-being. Furthermore, by advocating for user-friendly technologies and providing continuous digital mentorship,

authentic leaders reduce the anxiety and frustration linked to rapid technological shifts. Ultimately, this leadership style transforms technology from a source of stress into a tool for efficiency and resilience, ensuring that nurses remain engaged and supported in the most demanding clinical settings.

The current study revealed that half of the nurses were in the young adult category (25-35 years) and the majority were females with Bachelor's degrees. This profile reflects the typical workforce in Egyptian university hospitals, where younger generations are more integrated into high-tech units. These findings are **in agreement with Emara, (2021)**, who noted that Egyptian ICUs are predominantly staffed by young BSN graduates. However, this **contradicts** some Western studies like **Endacott et al., (2022),** where ICU nursing staff tend to be older with more than 15 years of experience.

The current study revealed that the plurality of ICU nurses were in their twenties, and more than three fifths held a Bachelor's degree. This indicates a young, academically qualified nursing workforce. These findings are **in accordance with Ismail et al. (2025),** who found that the majority of nurses in Egyptian high-tech units are young BSN holders, as they are often more capable of handling digital complexities. Conversely, these results **disagree with Peterson (2021)** in the USA, where the ICU workforce is predominantly composed of older nurses with higher postgraduate representation.

The results revealed a highly statistically significant improvement in the nurses' perception of Authentic Digital Leadership post-intervention, this percentage significantly decreased, while less than three quarters of the nurses reported a High Level of digital leadership perception.

The results revealed a dramatic transition in the perceived levels of ADL, where high-level perception rose post-intervention. This shift indicates that nursing supervisors were highly responsive to the training program, successfully integrating digital transparency and ethical self-awareness into their clinical management. This finding is **consistent with Khan et al. (2025),** who reported that structured leadership interventions in digitalized healthcare settings can significantly shift staff perception from distrust to high engagement. On the contrary, this **disagrees with Jerab, & Mabrouk, (2023),** who found that leadership behaviors in high-tech units are resistant to change due to deep-seated traditional administrative cultures.

The most significant finding was the highly statistically significant reduction in burnout dimensions—specifically emotional exhaustion—following the leadership intervention. This suggests that when leaders at Sohag University Hospitals practice digital transparency and ethical processing, it alleviates the "Technostress" associated with ICU devices. This result is supported by **Zeike et al. (2019),** who found that digital leadership skills are negatively associated with psychological distress. On the other hand, it differs from **Wei (2020),** who argued that leadership alone cannot mitigate burnout without structural changes like increasing staff-to-patient ratios.

The study showed a substantial decline in "High Emotional Exhaustion" and a significant boost in "High Personal Accomplishment". These results suggest that ADL acts as a powerful psychological intervention that restores nurses' sense of control over ICU technologies. These findings are supported **by Navarro Martínez et al. (2024)**, who demonstrated that "Authentic Digital Leaders" reduce the prevalence of high-level burnout by providing emotional and technical support during digital transitions. However, these results differ from **Miller &**

Hemberg, (2023), who observed that despite positive leadership, high burnout levels persisted due to physical workload factors that leadership alone could not address.

This result is consistent with **Zeike et al. (2019),** who emphasized that digital leadership interventions significantly improve the organizational climate. Regarding burnout, the dramatic decrease in "Emotional Exhaustion" and "Depersonalization" matches the findings of **Navarro Martínez et al. (2024)**, who reported that transparent and ethical digital leadership reduces technostress in critical care settings. However, this contradicts **Kadosh & Rozani, (2025),** who argued that digital leadership alone cannot reduce burnout without increasing physical staff numbers.

Findings of the current study displayed the correlation between the perceived Authentic Digital Leadership (ADL) and burnout dimensions. A strong negative correlation was found between ADL and Emotional Exhaustion, suggesting that as digital leadership quality improves, nurse burnout significantly decreases. Additionally, a positive correlation was observed with Personal Accomplishment, supporting the study's hypotheses. The significant increase in "Personal Accomplishment" scores post-intervention suggests that ADL empowers nurses to master ICU technologies rather than fear them. This is in line with **Lambert et al. (2024)**, who found that ethical digital processing boosts nurses' sense of professional efficacy and self-worth.

The strong negative correlation between ADL and Emotional Exhaustion suggests that as leadership becomes more "authentic" and "digitally aware," nurses feel less psychologically drained by technology. This is supported **by** the *Authentic Leadership Theory* **(Avolio & Gardner, 2005)**, which links leadership transparency to reduced staff stress. Locally, it **aligns with Alsayed et al., (2021),** who found that supervisor support is the primary shield against burnout in Upper Egypt's hospitals. Interestingly, this result differs from **Jiaqing et al., (2025),** whose study showed no significant correlation, possibly due to a lack of digital tools in the setting he studied, unlike the high-tech units.

This aligns with **Hossny et al., (2023)**, who found that leadership support in Upper Egypt hospitals significantly enhances nurse retention. Conversely, **Miller & Hemberg, (2023),** found a weaker correlation, suggesting that in extremely under-resourced settings, the impact of leadership authenticity might be overshadowed by physical exhaustion.

The increase in "Personal Accomplishment" scores post-intervention indicates that ADL empowers nurses to master ICU technologies. This is consistent with **Lambert et al. (2024),** who reported that ethical digital leadership boosts professional efficacy.

The current study confirms that the changes in burnout levels before and after the intervention are highly statistically significant. This statistically proves that the Authentic Digital Leadership program was effective in reducing burnout dimensions among ICU nurses. The highly statistically significant results ($\chi 2$ values with $P<0.001$) across all burnout dimensions confirm the effectiveness of the intervention. This statistical evidence aligns with the study of **Lambert et al. (2024)**, which proved that targeted digital leadership programs yield significant clinical improvements in nursing work environments. Locally, this matches **Hossny et al. (2023)**, whose research at Egyptian university hospitals indicated that standardized leadership training is the most effective tool for mitigating staff depersonalization. In contrast, **Jiaqing et al.,**

(2025), found non-significant changes in burnout levels after a similar intervention, attributing the failure to a lack of technical infrastructure, which differs from the high-tech environment.

Conclusion

The study concludes that authentic digital leadership is a critical determinant in mitigating nurse burnout within high-tech critical care environments. By fostering digital transparency, ethical technology processing, and relational trust, leaders can significantly buffer the negative impacts of "technostress" and emotional exhaustion among ICU nurses. The transition from traditional leadership to an authentic digital approach has proven hypothetically to decrease burnout levels and enhance nurses' professional efficacy. Ultimately, integrating the "human element" with digital proficiency is the most effective strategy for sustaining a healthy, resilient, and high-performing nursing workforce in the era of digital health transformation.

Recommendations

- Implement specialized training programs for head nurses and supervisors focusing on the four pillars of Authentic Digital Leadership (Self-awareness, Transparency, Ethical Processing, and Balanced Decision-making).
- Establish a "Digital Support Unit" to provide technical assistance to ICU nurses, reducing the cognitive load and frustration associated with equipment malfunctions.
- Develop clinical protocols that prioritize patient-nurse interaction over machine-monitoring tasks to reduce depersonalization.
- Conduct periodic assessments of burnout levels among ICU staff using the Maslach Burnout Inventory (MBI) to identify early signs of emotional exhaustion.
- Incorporate "Digital Leadership" and "Informatics Ethics" into undergraduate and postgraduate nursing curricula to prepare future nurses for high-tech environments.
- Provide ongoing workshops for staff nurses on coping mechanisms for tech-related stress and alarm fatigue.
- Conduct follow-up studies over longer periods (12 months) to assess the long-term sustainability of the ADL intervention.
- Perform qualitative interviews to explore the lived experiences of nurses regarding "Digital Authenticity" in Upper Egypt's cultural context.
- Replicate the study across multiple university hospitals in Egypt to generalize the findings.

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