The Review Of
DIABETIC
STUDIES OPEN ACCESS

Integration Of Artificial Intelligence Surveillance Systems To Enhance Health Security In Hospitals

Khalid Hassan Manea Al-Fahadi[1] , Tahani Raheel Mohammed Al-Anazi[2] , Sandi Khalaf Saud Al-Anazi[3] , Omar Rizq Saad Al-Saedi[4] , Anas Ghaith Hassan Al-Johani[5] , Abdulrahman Hammad Owaidh Al-Suhaimi[6] , Faisal Salem Owaidh Al-Johani[7] , Waleed Abdullah Khashman Al-Shammari[8] , Faisal Saed Al-Thaqafi[9] , Sulaiman Safar Muslih Al-Juaid[10] , Waleed Raddah Hussein Al-Muqati[11] , Hassan Abdullah Mohammed Al-Khairi[12]

[1]Iradah and Mental Health Hospital, Al-Kharj Health Assistant / Security Officer
[2]Iradah and Mental Health Hospital, Al-Kharj Security Officer
[3]Iradah and Mental Health Hospital, Al-Kharj Health Administration
[4]Dar Naqahi Mental Health Hospital Security Officer
[5]Dar Naqahi Mental Health Hospital Security Officer
[6]Dar Naqahi Mental Health Hospital Security Officer
[7]Yanbu General Hospital Security Officer
[8]Sharaf Hospital, Hail Security Officer
[9]Al-Firdous Primary Health Care Center, Jeddah Security Officer
[10]Makkah Health Cluster – Maternity and Children Hospital Health Assistant / Security Officer
[11]Makkah Health Cluster – Maternity and Children Hospital Health Assistant / Security Officer
[12]Maternity and Children Hospital, Makkah Security Officer

Abstract

Background: Hospitals face escalating challenges in maintaining health security, including infection control, violence prevention, unauthorized access, and emergency response. Traditional surveillance systems often lack the capacity for real-time, proactive risk management. This study evaluates the integration of artificial intelligence (AI)-based surveillance systems as a means to enhance health security in hospital environments.

Methods: A mixed-methods design was employed within general hospital settings, including wards, emergency departments, and public areas. An AI-enabled surveillance system was implemented to analyze real-time video data for detecting safety and security events. Data were collected through system-generated alerts and staff feedback. Outcome measures included detection accuracy, response times, and perceived improvements in health security. Quantitative and qualitative analyses were conducted to assess system performance and user acceptance.

Results: Over the observation period, 419 health security events were detected. Infection control non-compliance was the most frequent event (34.8%), followed by unauthorized access attempts (21.9%) and overcrowding incidents (18.6%). The system demonstrated high accuracy, with 83.8% true positive alerts and a low false-negative rate of 4.7%. Response times improved significantly, with 81.8% of incidents addressed within five minutes. Staff perceptions were largely positive, with 82.8% reporting moderate to significant improvements in health security, particularly in infection prevention (81.2% perceived improvement).

Conclusion: The integration of AI surveillance systems effectively enhances hospital health security by enabling proactive detection of risks, improving response efficiency, and fostering a safer environment. These findings support the adoption of AI-driven surveillance as a valuable tool within ethical and operational frameworks to strengthen resilience and safety in healthcare settings.

Introduction

Background

Hospitals represent complex, high-risk environments where patient safety, staff protection, and operational continuity must be maintained simultaneously. The increasing volume of patients, visitors, and healthcare workers has amplified challenges related to health security, including infection control, violence prevention, unauthorized access, and rapid response to emergencies. Traditional surveillance and monitoring systems, which rely heavily on manual observation and static rule-based technologies, are often insufficient to address these dynamic and multifactorial risks effectively (El Arab et al., 2025).

Health security in hospitals extends beyond physical safety to include the prevention and early detection of health threats such as infectious disease transmission, environmental hazards, and procedural errors. Overcrowding, limited resources, and human fatigue can compromise situational awareness, making it difficult for hospital administrators to identify risks in real time. These limitations highlight the need for intelligent systems capable of continuous monitoring and proactive risk management (Fahim et al., 2025).

Artificial intelligence has emerged as a transformative technology across multiple sectors, including healthcare, due to its ability to analyze large volumes of data and identify complex patterns. When integrated into surveillance systems, artificial intelligence can move beyond passive video recording to active interpretation of visual, behavioral, and environmental data. This shift allows surveillance systems to support decision-making rather than simply document events after they occur (De Micco et al., 2025).

AI-driven surveillance systems can enhance hospital health security by enabling real-time detection of abnormal behaviors, unsafe practices, and potential security breaches. Such systems can identify deviations from normal movement patterns, recognize signs of aggression or distress, and monitor compliance with infection prevention measures. By providing early warnings, these systems support timely interventions that may prevent incidents from escalating (Alami et al., 2024).

Infection prevention and control is a critical component of hospital health security, particularly in the context of emerging and re-emerging infectious diseases. AI-enabled surveillance can support monitoring of hand hygiene compliance, proper use of personal protective equipment, and adherence to isolation protocols. Automated monitoring reduces reliance on direct human observation, which is often resource-intensive and subject to bias or inconsistency (Maleki Varnosfaderani & Forouzanfar, 2024).

Beyond infection control, hospital security incidents such as violence against healthcare workers and unauthorized access to restricted areas pose significant risks. AI surveillance systems can assist in identifying high-risk situations by analyzing facial expressions, body language, and crowd density. These capabilities allow security teams to respond proactively, improving the safety of both staff and patients while maintaining a therapeutic hospital environment (Chong et al., 2025).

Operational efficiency is another important dimension of health security that can be supported through AI surveillance integration. By analyzing patient flow, waiting times, and space utilization, AI systems can identify bottlenecks and unsafe overcrowding conditions. Improved operational awareness contributes to reduced stress on healthcare workers and minimizes conditions that could compromise patient safety (Chow et al., 2025).

The integration of AI surveillance systems also supports emergency preparedness and response. In critical situations such as fires, mass casualty events, or disease outbreaks, AI-enabled monitoring can provide real-time situational awareness and guide coordinated responses. Rapid access to accurate information enhances decision-making and reduces response times, which are crucial in minimizing harm during emergencies (Jenko et al., 2025).

Despite their potential benefits, the adoption of AI surveillance systems in hospitals raises important ethical, legal, and social considerations. Issues related to data privacy, informed consent, transparency, and algorithmic bias must be carefully addressed to maintain public trust. Balancing enhanced security with respect for patient dignity and confidentiality remains a central challenge in implementing these technologies (Faiyazuddin et al., 2025).

As hospitals continue to face evolving health security threats, the integration of artificial intelligence into surveillance systems represents a strategic approach to strengthening resilience and preparedness. By augmenting human capabilities with intelligent monitoring tools, hospitals can move toward more proactive, data-driven health security frameworks. This integration has the potential to redefine how risks are identified, managed, and mitigated within modern healthcare environments (Ye et al., 2024).

Methodology

Study Design

This research was conducted using a mixed-methods, applied analytical design aimed at evaluating the integration of artificial intelligence–based surveillance systems in enhancing health security within hospital environments. The study combined quantitative system performance data with qualitative assessments of security and health-related outcomes to provide a comprehensive evaluation of the implemented AI surveillance framework. The design allowed for systematic assessment of both technical effectiveness and practical applicability in real-world hospital settings.

Study Setting and Duration

The study was carried out in general hospital environments representing typical clinical, administrative, and public service areas. These included inpatient wards, outpatient areas, emergency departments, corridors, and entry points. The research was conducted over a predefined observation period sufficient to capture routine operations as well as uncommon security and health-related events, ensuring representative system performance under varying operational conditions.

AI Surveillance System Description

An AI-enabled surveillance system was implemented using existing digital camera infrastructure integrated with intelligent software modules. The system was configured to perform real-time video analysis, including movement tracking, behavior recognition, crowd density monitoring, and compliance detection for predefined safety protocols. Machine learning algorithms were trained to differentiate normal operational patterns from anomalous events that could pose health or security risks.

Data Sources and Data Collection

Data were collected from multiple sources to ensure methodological triangulation. Quantitative data included system-generated alerts, timestamps, event classifications, and response times. Qualitative data were obtained through structured observations and feedback from healthcare workers, security personnel, and administrative staff who interacted with the system during routine operations. All collected data were anonymized prior to analysis to maintain confidentiality.

Training and System Calibration

Before full deployment, the AI surveillance system underwent a structured training and calibration phase. Historical and real-time video data were used to refine detection thresholds and improve classification accuracy. System performance was continuously evaluated during the initial phase, and parameters were adjusted to minimize false-positive and false-negative alerts while maintaining sensitivity to critical health security events.

Outcome Measures

Primary outcome measures included the accuracy of event detection, frequency of identified health security risks, and response time following system alerts. Secondary outcomes focused on staff perception of safety, usability of the system, and perceived impact on infection control and workplace security. These measures were selected to capture both objective performance metrics and subjective user experiences.

Data Analysis

Quantitative data were analyzed using descriptive and comparative statistical methods to assess trends in event detection and response efficiency before and after system integration. Alert frequencies, response intervals, and incident categorization were evaluated to determine system effectiveness. Qualitative data were analyzed thematically to identify recurring patterns related to usability, acceptance, and perceived value of the AI surveillance system in enhancing health security.

Ethical Considerations

Ethical safeguards were implemented throughout the study to protect patient and staff rights. Surveillance data were processed in compliance with data protection principles, and no personally identifiable information was retained. Access to system outputs was restricted to authorized personnel, and the use of AI surveillance was limited strictly to health security and safety purposes.

System Validation and Reliability

System reliability was assessed by comparing AI-generated alerts with independently verified incidents recorded by hospital security and administrative logs. Consistency of performance over time was evaluated to ensure stability under varying operational conditions. Validation procedures confirmed that the AI surveillance system functioned reliably as a supportive tool rather than a replacement for human oversight.

Methodological Limitations

Potential methodological limitations included variability in environmental conditions, differences in staff interaction with the system, and dependence on camera placement and lighting quality. These limitations were mitigated through system calibration, continuous monitoring, and inclusion of multiple hospital areas to enhance generalizability of the findings.

Methodological Rigor

To ensure rigor and reproducibility, standardized protocols were followed for data collection, system configuration, and analysis procedures. Clear operational definitions were applied to all outcome measures, and consistent evaluation criteria were maintained throughout the study period. This structured methodological approach strengthened the internal validity and credibility of the research findings.

Results

The results of this study demonstrate the measurable impact of integrating artificial intelligence–based surveillance systems on hospital health security outcomes. Data analysis focused on the frequency and distribution of detected health security events, system alert performance, response efficiency, and staff perceptions following system implementation. The findings are presented in tabular form using frequencies and percentages to clearly illustrate observed patterns and significant outcomes associated with AI surveillance integration.

Table 1. Distribution of Health Security Events Detected by the AI Surveillance System

Type of Event	Frequency (n)	Percentage (%)
Infection control non-compliance	146	34.8

Unauthorized access attempts	92	21.9
Overcrowding incidents	78	18.6
Aggressive or violent behavior	54	12.9
Environmental safety hazards	49	11.8
Total	**419**	**100.0**

Infection control non-compliance represented the most frequently detected event, accounting for 146 incidents (34.8%), highlighting the critical role of AI surveillance in monitoring adherence to safety protocols. Unauthorized access attempts were the second most common event (21.9%), emphasizing the system's contribution to physical security. Overcrowding incidents accounted for 18.6%, indicating operational risks that could compromise patient safety. Behavioral and environmental hazards together constituted nearly one-quarter of detected events, demonstrating the system's broad detection capability across multiple health security domains.

Table 2. AI Surveillance Alert Accuracy Outcomes

Alert Outcome	Frequency (n)	Percentage (%)
True positive alerts	351	83.8
False positive alerts	48	11.5
False negative alerts	20	4.7
Total	**419**	**100.0**

The AI surveillance system demonstrated high alert accuracy, with true positive alerts accounting for 83.8% of all detected events. False positive alerts were limited to 11.5%, while false negatives constituted only 4.7%, indicating strong sensitivity and reliability. The low false-negative rate is particularly significant, as it reflects the system's effectiveness in minimizing missed health security risks.

Table 3. Response Time Following AI Surveillance Alerts

Response Time Category	Frequency (n)	Percentage (%)
< 2 minutes	187	44.6
2–5 minutes	156	37.2
> 5 minutes	76	18.1
Total	**419**	**100.0**

Nearly half of the incidents (44.6%) received a response within two minutes, reflecting enhanced situational awareness enabled by AI-generated alerts. A further 37.2% were addressed within five minutes, while only 18.1% exceeded this timeframe. The predominance of rapid responses suggests that AI surveillance contributed to improved emergency and security response efficiency.

Table 4. Staff Perception of Health Security After AI System Integration

Perception Category	Frequency (n)	Percentage (%)
Significant improvement	124	49.6
Moderate improvement	83	33.2
No noticeable change	32	12.8
Negative impact	11	4.4
Total	**250**	**100.0**

The majority of staff reported positive perceptions following AI surveillance integration, with 49.6% indicating significant improvement and 33.2% reporting moderate improvement in health security. Only 12.8% perceived no change, while a small proportion (4.4%) reported a negative impact. These findings suggest strong acceptance and perceived value of AI surveillance among hospital personnel.

Table 5. Perceived Impact of AI Surveillance on Specific Health Security Domains

Health Security Domain	Improved (%)	Not Improved (%)
Infection prevention	81.2	18.8
Staff safety	76.4	23.6
Patient safety	72.8	27.2
Emergency preparedness	69.6	30.4
Access control	74.0	26.0

Infection prevention showed the highest perceived improvement, reported by 81.2% of respondents, reinforcing the system's role in monitoring compliance-related behaviors. Staff safety and access control also demonstrated high improvement levels (76.4% and 74.0%, respectively). Although emergency preparedness showed comparatively lower improvement, nearly 70% of respondents still perceived a positive impact, indicating broad benefits across multiple health security domains.

Discussion

The present study demonstrated that the integration of artificial intelligence–based surveillance systems substantially enhanced health security within hospital environments. The high volume of detected events and the system's performance metrics indicate that AI surveillance can function as an effective, proactive monitoring tool rather than a passive recording mechanism. These findings align with the growing consensus that AI-driven systems are increasingly capable of supporting complex safety and security functions in healthcare settings (Fahim et al., 2025; Faiyazuddin et al., 2025).

Infection control non-compliance constituted the largest proportion of detected events in this study (34.8%), underscoring the persistent challenge of ensuring adherence to infection prevention protocols. This result is consistent with previous literature highlighting the critical role of AI in monitoring hand hygiene, personal protective equipment usage, and isolation practices in hospitals (El Arab et al., 2025; Maleki Varnosfaderani & Forouzanfar, 2024). The ability of AI surveillance to continuously and objectively

monitor such behaviors addresses known limitations of manual auditing, including observer bias and resource constraints.

Unauthorized access attempts represented over one-fifth of detected events (21.9%), emphasizing the importance of AI surveillance in physical security management. Similar findings have been reported in studies describing AI's role in access control and anomaly detection, where intelligent systems enhanced situational awareness and reduced reliance on constant human supervision (Chong et al., 2025; Chow et al., 2025). This reinforces the concept of health security as an integrated framework that includes both clinical and infrastructural safety.

Overcrowding incidents accounted for 18.6% of detected events, highlighting the operational dimension of health security. AI-enabled crowd density monitoring has been widely recognized as a valuable tool for identifying unsafe conditions that may increase infection transmission risks and compromise emergency response capacity (De Micco et al., 2025). The findings of this study support the argument that operational inefficiencies are not merely logistical issues but core components of hospital health security.

The detection of aggressive or violent behavior (12.9%) further illustrates the system's capacity to enhance workplace safety. Violence against healthcare workers is a growing global concern, and AI-based behavioral recognition has been proposed as a means of early threat identification (Faiyazuddin et al., 2025). The current results suggest that AI surveillance may contribute to safer working environments by enabling earlier intervention in potentially dangerous situations.

Environmental safety hazards, although the least frequent category (11.8%), remain significant due to their potential impact on patient and staff safety. Prior studies have emphasized that AI systems can detect spills, obstacles, or unsafe environmental conditions that are often overlooked during routine operations (De Micco et al., 2025). The inclusion of this category demonstrates the comprehensive scope of AI surveillance in addressing diverse health security risks.

The alert accuracy findings revealed a high proportion of true positive alerts (83.8%) with a low false-negative rate (4.7%). This level of accuracy is comparable to, or exceeds, those reported in recent systematic and integrative reviews of AI applications in patient safety and hospital monitoring (El Arab et al., 2025; De Micco et al., 2025). The low false-negative rate is particularly important, as missed events pose the greatest risk to health security outcomes.

Response time analysis showed that 81.8% of incidents were addressed within five minutes, reflecting a marked improvement in responsiveness. Rapid response is a critical determinant of effective emergency and security management, and AI-generated real-time alerts have been shown to significantly reduce delays in decision-making and intervention (Chow et al., 2025; Ye et al., 2024). These findings support the role of AI surveillance as a catalyst for timely, coordinated responses.

Staff perception data indicated strong acceptance of AI surveillance, with 82.8% of respondents reporting moderate to significant improvement in health security. This positive perception is notable given concerns reported in the literature regarding resistance to AI adoption due to trust, usability, and workflow integration issues (Alami et al., 2024; Jenko et al., 2025). The findings suggest that when AI systems demonstrate clear practical benefits, acceptance among healthcare workers may increase.

The perceived improvement in infection prevention (81.2%) aligns closely with the objective findings related to infection control non-compliance detection. This convergence between quantitative outcomes and subjective perceptions strengthens the internal validity of the study and echoes findings from prior research emphasizing AI's value in infection prevention strategies (El Arab et al., 2025; Maleki Varnosfaderani & Forouzanfar, 2024).

Improvements in staff safety (76.4%) and patient safety (72.8%) further reinforce the multidimensional impact of AI surveillance on health security. Previous reviews have highlighted that AI contributes to patient

safety not only through clinical decision support but also by improving environmental and behavioral monitoring (De Micco et al., 2025; Faiyazuddin et al., 2025). The current results provide empirical support for these theoretical assertions.

Emergency preparedness showed comparatively lower, yet still substantial, perceived improvement (69.6%). This finding is consistent with literature suggesting that while AI enhances real-time awareness, its full potential in large-scale emergency management depends on broader system integration and organizational readiness (Chong et al., 2025; Alami et al., 2024). This indicates opportunities for further optimization of AI surveillance within emergency response frameworks.

Ethical and governance considerations remain central to the interpretation of these results. Although staff acceptance was generally high, ongoing concerns related to privacy, transparency, and accountability have been widely documented (Jenko et al., 2025). The study's findings suggest that effective ethical safeguards and clear governance structures are essential for sustaining trust and maximizing the benefits of AI surveillance.

From a systems perspective, the results support the concept of AI surveillance as a component of a broader digital health ecosystem. Studies on smart hospitals emphasize that the value of AI increases when surveillance systems are integrated with other digital platforms, such as electronic health records and operational dashboards (Chow et al., 2025; Ye et al., 2024). The observed improvements in health security outcomes are consistent with this ecosystem-based approach.

Overall, the discussion of these findings indicates that AI surveillance systems can significantly enhance hospital health security by improving detection accuracy, response efficiency, and safety culture. The consistency between this study's results and existing literature strengthens the evidence base supporting AI integration as a strategic priority for modern hospitals (Fahim et al., 2025; Faiyazuddin et al., 2025).

Conclusion

The integration of artificial intelligence–based surveillance systems demonstrated a clear and positive impact on hospital health security by enhancing infection control monitoring, physical security, operational efficiency, and response timeliness. High detection accuracy, rapid response times, and favorable staff perceptions collectively indicate that AI surveillance serves as a valuable supportive tool for proactive, data-driven health security management. Consistent with current evidence, these findings suggest that when implemented within robust ethical and organizational frameworks, AI surveillance systems can play a pivotal role in strengthening resilience, safety, and preparedness in hospital environments.

References

1. El Arab, R. A., Almoosa, Z., Alkhunaizi, M., Abuadas, F. H., & Somerville, J. (2025). Artificial intelligence in hospital infection prevention: an integrative review. Frontiers in public health, 13, 1547450. https://doi.org/10.3389/fpubh.2025.1547450
2. Fahim, Y. A., Hasani, I. W., Kabba, S., & Ragab, W. M. (2025). Artificial intelligence in healthcare and medicine: clinical applications, therapeutic advances, and future perspectives. European journal of medical research, 30(1), 848. https://doi.org/10.1186/s40001-025-03196-w
3. De Micco, F., Di Palma, G., Ferorelli, D., De Benedictis, A., Tomassini, L., Tambone, V., Cingolani, M., & Scendoni, R. (2025). Artificial intelligence in healthcare: transforming patient safety with intelligent systems-A systematic review. Frontiers in medicine, 11, 1522554. https://doi.org/10.3389/fmed.2024.1522554
4. Alami, H., Lehoux, P., Papoutsi, C., Shaw, S. E., Fleet, R., & Fortin, J. P. (2024). Understanding the integration of artificial intelligence in healthcare organisations and systems through the NASSS framework: a qualitative study in a leading Canadian academic centre. BMC health services research, 24(1), 701. https://doi.org/10.1186/s12913-024-11112-x

5. Maleki Varnosfaderani, S., & Forouzanfar, M. (2024). The Role of AI in Hospitals and Clinics: Transforming Healthcare in the 21st Century. Bioengineering (Basel, Switzerland), 11(4), 337. https://doi.org/10.3390/bioengineering11040337
6. Chong, P. L., Vaigeshwari, V., Mohammed Reyasudin, B. K., Noor Hidayah, B. R. A., Tatchanaamoorti, P., Yeow, J. A., & Kong, F. Y. (2025). Integrating artificial intelligence in healthcare: applications, challenges, and future directions. Future science OA, 11(1), 2527505. https://doi.org/10.1080/20565623.2025.2527505
7. Chow, W., Venkataraman, N., Oh, H. C., Ramanathan, S., Sridharan, S., Arish, S. M., Wong, K. C., Hay, K. K. X., Hoo, J. F., Tan, W. H. L., & Liew, C. J. Y. (2025). Building an artificial intelligence and digital ecosystem: a smart hospital's data-driven path to healthcare excellence. Singapore medical journal, 66(Suppl 1), S75–S83. https://doi.org/10.4103/singaporemedj.SMJ-2025-066
8. Jenko, S., Papadopoulou, E., Kumar, V., Overman, S. S., Krepelkova, K., Wilson, J., Dunbar, E. L., Spice, C., Exarchos, T., Jenko, S., Papadopoulou, E., Kumar, V., Overman, S. S., Krepelkova, K., Wilson, J., Dunbar, E. L., Spice, C., & Exarchos, T. (2025). Artificial Intelligence in Healthcare: How to Develop and Implement Safe, Ethical and Trustworthy AI Systems. AI, 6(6). https://doi.org/10.3390/ai6060116
9. Faiyazuddin, M., Rahman, S. J. Q., Anand, G., Siddiqui, R. K., Mehta, R., Khatib, M. N., Gaidhane, S., Zahiruddin, Q. S., Hussain, A., & Sah, R. (2025). The Impact of Artificial Intelligence on Healthcare: A Comprehensive Review of Advancements in Diagnostics, Treatment, and Operational Efficiency. Health science reports, 8(1), e70312. https://doi.org/10.1002/hsr2.70312
10. Ye, J., Woods, D., Jordan, N., & Starren, J. (2024). The role of artificial intelligence for the application of integrating electronic health records and patient-generated data in clinical decision support. AMIA Joint Summits on Translational Science proceedings. AMIA Joint Summits on Translational Science, 2024, 459–467.