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Integrating Health Informatics with Hospital Management Strategies to Combat Hospital-Acquired Infections: A Quantitative Study in Saudi Arabia

[1]*Mohammed Hassan Jokeir Al Mansour, [2]Aedh Saad Aedgh Alqathani, [3]Sultan Mohammed Saad Al shahrani, [4]Khalid Saeed Alqahtani, [5]Hussain Jaber Ayami, [6]Ahmed Omar Altowairqi
[1,2,3,4,5,6]Armed Forces Hospital, Najran, Kingdom of Saudi Arabia (KSA).

Abstract
Background: Hospital-acquired infections presents a persistent challenge in healthcare systems worldwide thereby contributing to increased morbidity, mortality and healthcare costs. Though recent advances in health informatics are encouraging nevertheless, integration between the health informatics and hospital management has been rarely explored especially in the context of Saudi Arabia.
Objective: The study aimed at measuring healthcare workers' perceptions regarding the integration of health informatics systems within hospital management specifically for HAI control.
Methods: Cross-sectional quantitative survey was undertaken comprising 350 healthcare professionals across Saudi Arabian hospitals through stratified random sampling. A validated questionnaire comprising 45 items across three scales (Health Informatics Scale, Management Strategies Scale and Integration Effectiveness Scale) was administered via Google Forms. Analysis was performed using Python in Google Colaboratory where descriptive statistics, reliability analysis, exploratory factor analysis, one-way ANOVA with Tukey post-hoc tests along with Pearson correlations, multiple regression, and path analysis was performed.
Results: Chosen scales demonstrated acceptable to good reliability based on Cronbach's $\alpha = 0.65$-0.82. Statistical significant differences in integration effectiveness perceptions were found across professional roles ($F=21.157$, $p<0.001$), where infection prevention and control specialists measured as highest scores ($M=3.89$). Both health informatics ($r=0.372$, $p<0.001$) and management strategies ($r=0.254$, $p<0.001$) has significantly correlation with integration effectiveness. Regression analysis suggested that both predictors explained 20.4% of variance in integration effectiveness ($R^2= 0.204$, $F = 44.33$, $p<0.001$).
Conclusion: The findings confirm hypothesized relationships between health informatics, management strategies and integration effectiveness. Healthcare institutions need to prioritize collaborative approaches that bridge technological and administrative domains in order to enhance HAI prevention efforts.

Keywords: Health Informatics, Hospital Management, Hospital-Acquired Infections, Integration, Saudi Arabia, Quantitative Research.

1. Introduction

Hospital-acquired infections (HAIs) also referred to as healthcare-associated infections demonstrate significant challenges which modern healthcare systems are facing globally. Notably, the infections that patients receive during the course of treatment significantly contribute to morbidity, mortality and healthcare expenditures for patients (Haque et al., 2018). As per the estimates of The World Health Organization, significant patients across the globe each year are affected by HAI. More specifically, these estimates are in millions and ranges from 3.5% to 12% in developed countries (World Health, 2022). Within Saudi Arabia, HAIs establishes major public health concern with the estimates for around 8 to 15 % across its healthcare facilities (Al-Tawfiq & Tambyah, 2014; Balkhy et al., 2019)

However, the increased prevalence of HAI has now been extended beyond immediate clinical outcomes. The reason being prolonged hospital stays, enhanced antimicrobial resistance, additional diagnostic and therapeutic costs leading to substantial economic losses for the entire healthcare system (Zimlichman et al., 2013). Apart from these economic losses and burden, HAI also imposes considerable emotional and psychological burdens

Mohammed Hassan Jokeir Al Mansour
Armed Forces Hospital, Najran, Kingdom of Saudi Arabia (KSA).
Email: mohammed.9138@hotmail.com

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on patients, families as well as healthcare workers. Consequently, this undermines trust and capabilities of healthcare institutions because of their compromised quality and care delivery (Mitchell et al., 2017).

Notably, health informatics has now emerged as a promising domain for countering HAIs because of distinct and effective technological interventions. More precisely, electronic medical records (EMRs) are capable for comprehensive documentation and tracking of patient information thereby facilitating early identification of infectious diseases (Cresswell & Sheikh, 2013). In addition, clinical decision support systems (CDSS) provides real-time alerts to clinicians and facilitates in identifying potential infection risks, antibiotic prescribing guidelines and isolation precautions (Roshanov et al., 2013). Apart from this, surveillance dashboards with their ability to showcase diverse form of data enable healthcare administrators to monitor trends, outbreaks and provide adequate response strategy (Freeman et al., 2013).

Further, predictive analytics which leverage machine learning algorithms and big data is also offering considerable opportunities for proactive identification of high-risk patients prior to infections occur (Sanger et al., 2016). Even though these technological capabilities are being improvised, the limited presence of informatics tools does not guarantee effective HAI prevention. Hence, successful translation of informatics capabilities into improved infection control outcomes is largely dependent on how these tools are integrated with organizational management strategies (Kruse et al., 2018).

Management strategies for infectious control encompass wide range of collaboration and coordination comprising policy development, staff training, resource allocation along with quality improvement initiatives (Zingg et al., 2015). As per Storr et al. (2017), some of the proven and effective management strategies for infections control are identified as hand hygiene campaigns, antimicrobial stewardship programs along with environmental cleaning protocols. However, effective and adequate implementation of these strategies is debatable as it requires strong leadership commitment, trained staff and sufficient financial resources under supportive organizational culture (Saint et al., 2019). Furthermore, training programs provides healthcare workers considerable opportunity to deploy and foster skills and knowledge necessarily require for implementing infection control practices (Labeau et al., 2020). In addition, compliance monitoring especially through audits and feedback also promotes adhere to established protocols serving as a baseline guidelines for the preventive control (Gould et al., 2017). Apart from this, Mitchell et al. (2019) suggested that accreditation standards and regulatory requirements also encourage reinforcement of organizational commitment and focus towards infectious diseases.

Though the contemporary literature establishes the importance of health informatics and the consequently applied strategies for HAI prevention nevertheless, a considerable literature gap still exists in adequately explaining how both health informatics can be fully integrated to healthcare management strategies. As per Cresswell and Sheikh (2013), health informatics system is operated in silos where they are disconnected from broader management processes and decision making structures. However, management strategies also get failed to leverage available informatics capabilities resulting in compromised decision making (Kruse et al., 2018). As a result of this, gap exist in current body of knowledge particularly in the identification of critical barriers to optimize HAI prevention efforts in achieving notable infection control outcomes.

Saudi Arabian healthcare context demonstrates unique characteristics that require considerable attention particularly with regards to its approaches towards health management. In the recent years, the Kingdom has invested substantially in healthcare infrastructure and information technology under its Vision 2030 (Ministry of Health, 2021). Nevertheless, empirical evidence regarding the integration of health informatics with management strategies for HAI control in Saudi hospitals remains limited. Understanding healthcare workers' perceptions of this integration can inform targeted interventions and policy recommendations through more robust and adequate framework for countering infectious diseases. Considering this, the present study aimed at addressing the following objectives:

O1: To compare perceptions of health informatics, management strategies and integration effectiveness across different professional roles.

O2: To identify key predictors of integration effectiveness in HAI control.

2. Literature Review

2.1 Hospital-Acquired Infections: Burden and Impact

Hospital acquired infections exhibit considerable public health challenge with long term consequences for patients, health care systems and societies as a whole.

As per Magill et al. (2018), specifically in the United States, an estimated 687,000 reported cases for HAI results in nearly 72,000 deaths each year. Some of the most common diseases include catheter associated urinary tract infections (CAUTIs), surgical site infections (SSIs), central line-associated bloodstream infections (CLABSIs), and ventilator-associated pneumonia (VAP) (Haque et al., 2018).

The findings such as Zimlichman et al. (2013) highlighted the prominence of investigating economic burden associated with HAI. As per the aforementioned research, specifically in the US, nearly $9.8 billion are spend for the control and management of surgical infections. In the context of Saudi Arabia, HAIs contribute significantly to the excessive healthcare costs because of extended hospital stays thereby emphasing for effective preventive strategies.

2.2 Health Informatics Tools in Infection Control

The emergence of digital tools and technologies has facilitated to the proliferation and increased usage of health informatics tools. As per Cresswell and Sheikh (2013), Electronic Medical Records (EMR) serve as the foundation for health information applications particularly and effectively utilized for the infections control and management. The comprehensive documentation of patients' information along with the ability of risk factor identification and diagnosis has now been possible through EMR. However, Roshanov et al. (2013), suggested that clinical decision support system has also facilitated EMR to enhance its functionality by means of real-time alerts and recommendations.

One of the tool is identified as surveillance systems which become vitally important for the standardized surveillance utilized for tracking infections rates and benchmarking. As per Dudeck et al. (2015), The National Healthcare Safety Network (NHSN) has signified the importance of surveillance systems that have become essential while meeting the challenges of contemporary and high burden patients' management. It has been discussed that automated surveillance systems are of significant importance because of their usage of natural language processing and machine learning algorithms offer competitiveness against manual burden of infection identification meanwhile improving sensitivity and timelines (Sips et al., 2017).

Moreover, in the current dynamics where data and its management has become crucially important, predictive analytics demonstrates a key role to combat infectious related diseases. The findings of Sanger et al. (2016) suggested machine models that are capable of predicting infectious diseases based on the health records and database have provided opportunities to health practitioners and clinical staff to take preventive measures leading to better management of such infectious diseases. Wiens et al. (2016) also demonstrated the potential of predictive models in identifying patients at risk for surgical site infections prior the spread of such diseases.

2.3 Management Strategies for Infection Prevention

As per Zingg et al. (2015), effective infection control and management require careful consideration of strategies developed and performed by multi-disciplinary teams and wider stakeholders. The aforementioned researcher identified eight key components by which hospital infection management depends on. The first is the organization level of infection control, bed occupancy, workload, staffing, resource availability, guidelines/ framework and their adherence, training and development and last the audit measures. However, adherence and implementation of aforementioned components also demands sustained leadership commitment and resource allocation.

Also, antimicrobial stewardship programs that exhibit critical management intervention for reducing HAI has the tendency to combat antimicrobial resistance. Barlam et al. (2016) put forwarded inclusive guidelines for implementing stewardship programs thereby emphasizing the importance of dedicated personnel, technology and technology infrastructure essentially require for this. Along with this, the findings of Luangasanatip et al. (2015) suggested hand hygiene programs incorporating multimodal strategies are considered effective in reducing HAI across diverse healthcare settings. Nevertheless, the aspects of training and competency assessment are unavoidable as these ensure healthcare workers possess sufficient knowledge and skillset require for an effective infection prevention. This has also been highlighted by Labeau et al. (2020) suggesting ongoing education programs address both foundational knowledge and emerging threats such as multidrug-resistant organisms. In addition, simulation based training has also shown promise in improving procedural skills pertaining to infection prevention (Alonso et al., 2019).

2.4 Integration Models and Evidence Gaps

In the recent past, scholars have made an attempt insights pertaining to health informatics. For instance, one

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of the study Kruse et al. (2018), based on the systematic literature inferred that significant variability exists in the implementation of health information technology and infection control. However, the aforementioned findings also raised considerable questions and emphasis on the successful integration of health information for achieving desired management outcomes. Similarly, another research such as (Cresswell & Sheikh, 2013), emphasized on the importance of considering socio-technical aspects and suggested the need for the successful integration of a sociotechnical framework. As per the aforementioned researcher, the importance of interdependence between technical systems and social organizational contexts is of clinically importance when meeting or desiring certain health management outcomes. It was also discussed, the technology implementation is required to be accompanied by corresponding changes in management practices, training along with organizational structures while achieving desired outcomes.

Specifically, to the context of Saudi Arabia, the literature significantly lacks in explaining how health informatics is integrating and evolving with the increased HAI among Saudi's health institutions. The findings such as Albarrak et al. (2017) has investigated barriers to health information technology and focused on the key determinants that reduce the adoption of health informatics. It was found that the factors such as inadequate training, resistance to change along with the insufficient technical are identified as some of the key determinants and barriers in the successful adoption and integration of health information tools and techniques for hospital management. However, specific attention to infection control applications and management integration remains scarce.

2.5 Conceptual Framework

This study focuses to establish the link between health informatics capabilities, management strategy quality and integration effectiveness for HAI control. Hence, the concept surrounds around both informatics capabilities (EMR systems, clinical decision support, surveillance tools, data quality) and management strategies (policies, training, resources, compliance monitoring) contribute to integration effectiveness. Professional role has been hypothesized to moderate perceptions of these relationships thereby reflecting differences in exposure to and involvement with informatics and management systems. Based on above literature review, following hypotheses were formulated:

H1: Perceptions of integration effectiveness differ significantly across professional roles (physicians, nurses, administrators, and IPC specialists).

H2: Health informatics effectiveness and management strategy quality are positively correlated with integration effectiveness.

3. Methodology

3.1 Study Design

This study employed a cross-sectional, quantitative research design in order to examine healthcare workers' perceptions of health informatics and management strategy integration for HAI control. This approach facilitated in answering quantifiable nature research questions and enabled efficient data collection across a large and geographically dispersed sample.

3.2 Population and Sampling

The target population involved healthcare professionals working in hospitals across Saudi Arabia. The samples mainly involved physicians, nurses, hospital administrators and infection prevention and control specialists. In terms of sampling technique, stratified random sampling was employed in order to ensure adequate representation of different professional roles. Using G*Power software power analysis for the adequate sample identification was performed. Effect size ($f^2 = 0.15$), alpha level of 0.05, and power of 0.80 was assumed leading to computation of sample size as 306. However, the target sample was set as 350 considering non-responsiveness and incompleteness of survey responses.

3.3 Inclusion and Exclusion Criteria

In terms of inclusion criteria, participants had to be currently employed in a Saudi Arabian hospital with at least six months of experience in their current role. Also, participants having regular interaction with health informatics systems or infection control activities were part of the survey process. On the other hand, temporary or contract workers with less than six months of tenure were excluded from the survey. Also, administrative staff without direct involvement in clinical or infection control functions were excluded from research.

3.4 Instrument Development

Self-administered survey questionnaire was developed comprising four sections with a total of 45 items. Section A included demographic information through eight items mainly addressing age, gender, professional role, educational qualification, years of experience, hospital type, bed capacity and geographic region. Section B was the Health Informatics Scale which comprised 15 items across three subscales. The scales were EMR and clinical decision support (5 items), surveillance and analytics (5 items), and data quality and interoperability (5 items). Items measured perceptions of informatics system capabilities, accessibility, usability and effectiveness for infection control purposes. Section C was related to the management strategies scale comprised 12 items across three subscales policies and protocols (4 items), training and education (4 items), and resources and compliance monitoring (4 items). Items measured perceptions of organizational management approaches to infection prevention. Section D involved the integration effectiveness scale which comprised 10 items assessing perceptions of how effectively health informatics and management strategies were integrated among institutions inquired. Items in Sections B, C and D employed five-point Likert scales ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

3.5 Instrument Validation

Content validity was performed by a panel (experts) comprising three health informatics specialists among which two were infection control practitioners while the one was hospital administrator. The Content Validity Index (CVI) was computed for each item with items scoring below 0.80 were eliminated. Along with this, pilot test was undertaken comprising 50 healthcare professionals also validated the developed scale. Based on findings of pilot study, minor wording modifications were made in order to improve clarity. Reliability analysis was also performed Cronbach's alpha with the alpha value of 0.7 as threshold.

3.6 Data Collection

The study was mainly cross sectional research where the collection of data took eight-week facilitated through Google Forms. The electronic survey link was distributed among hospital administrators, professional associations through social media platforms targeting Saudi healthcare professionals.

3.7 Ethical Considerations

The ethical approval was obtained by the Institutional Review Board. Informed consent was also obtained from all participants through an electronic consent form presented at the beginning of the survey. Participation were voluntary and had the right to withdrawn in case of any discomfort. Importantly, data was collected anonymously with no personally identifiable information recorded. Moreover, data was stored securely on password-protected servers accessible only to the research team. Any intervention done in research studies that involved human subjects was in line with the ethical guidelines of the institutional and / or national research committee and with the Helsinki declaration of 1964 and its subsequent amendments or similar ethical principles.

3.8 Statistical Analysis

Statistical analysis was performed using Python programming language in Google Colaboratory. The key packages utilized were pandas, numpy, scipy, statsmodels, pingouin, factor_analyzer and semopy. At first, descriptive statistics were computed for all demographic variables and scale items. This comprised frequencies, percentages, means and standard deviations. Moreover, internal consistency that is reliability was then also measured using Cronbach's alpha coefficients with values above 0.70 was considered acceptable. Further, exploratory factor analysis (EFA) was performed in order to examine the underlying structure of the measurement instruments. Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity were also performed for assessing factorability. Moreover, one-way analysis of variance (ANOVA) was also performed with a focus on Tukey's HSD post-hoc tests. This examineddifferences in scale scores across professional roles. In addition, Pearson correlation coefficients also assessed bivariate relationships among study variables. Multiple regression analysis identified predictors of integration effectiveness. Lastly, path analysis was also performed to assess hypothesized relationships among health informatics, management strategies and integration effectiveness.

4. Results

4.1 Sample Characteristics

A total of 350 healthcare professionals completed the survey. Table 1 presents the demographic characteristics of the surveyed respondents. It is notable that the majority of respondents were from the age bracket of 30-39 years comprising 33.1%. This was followed by respondents aged 20-29 comprising 26.6%. Also, there was representations from age 40-49 which comprised 25.4%. In addition, female participants comprised 54.6% of the sample

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whereas males represented 45.4%.

As far as professional roles are concerned, nurses formed the largest group comprising 38.3% followed by physicians 27.4%. Further, administrators comprised 14.3% whereas IPC specialists comprised 12.9%. There were also other healthcare professionals that accounted 7.1%. Moreover, educational qualifications were diverse with Bachelor's degree holders comprised 37.4% followed by Master's degree 33.1%. Further, there were also 18.3% doctorate with 11.1 diploma holders.

In terms of work experience, 24.9% respondents had 6-10 years of experience followed by 22.0% having 2-5 years. Moreover, 21.4% had the experience 11-15 years whereas 17.7% had more than 15 years. There were also 14.0% respondents who had having less than 2 years. Interestingly, almost half of the respondents that is 49.7% worked in government hospitals while 32.3% in private hospitals and 18.0% were the teaching staff in hospitals. The largest proportion of respondents that is 31.4% worked in the Central region. This was followed by Western region comprising 25.4%, Eastern with 16.9%, Northern with 13.4% while Southern as 12.9% respondents.

Table 1: Demographic Characteristics of Respondents (N = 350)

Characteristic	**n**	**%**
Professional Role		
Physician	96	27.4
Nurse	134	38.3
Administrator	50	14.3
IPC Specialist	45	12.9
Other	25	7.1
Hospital Type		
Government	174	49.7
Private	113	32.3
Teaching	63	18.0

4.2 Scale Reliability

Reliability analysis confirmed acceptable to good internal consistency across all scaled components. Table 2 presents Cronbach's alpha coefficients for each measurement component. The Health Informatics subscales exhibited acceptable reliability with Data Quality and Interoperability indicating the highest coefficient (α=0.823). This is followed by EMR and clinical decision support with α=0.802 and surveillance and analytics with α = 0.786. The total Health Informatics Scale achieved acceptable reliability of α = 0.733.

Management Strategies subscales demonstrated acceptable reliability that is Policies and Protocols obtained α = 0.786. Also, resources and compliance monitoring

Table 2: Scale Reliability Analysis (Cronbach's Alpha)

Scale	**Items**	**α**
HI: EMR & Clinical Decision Support	5	0.802
HI: Surveillance & Analytics	5	0.786
HI: Data Quality & Interoperability	5	0.823
Health Informatics Total	15	0.733
MS: Policies & Protocols	4	0.786
MS: Training & Education	4	0.774
MS: Resources & Compliance	4	0.781
Management Strategies Total	12	0.648
Integration Effectiveness	10	0.743

obtained α=0.781 whereas and training and education obtained α=0.774. The total Management Strategies Scale demonstrated a slightly lower reliability. Nevertheless, the alpha value was still acceptable as not falling least threshold of α=0.648. In terms of the Integration Effectiveness Scale demonstrated acceptable reliability, α= 0.743 adequately satisfy the reliability criteria.

4.3 Descriptive Statistics

Table 3 demonstrated descriptive statistics with Mean scores, standard deviation and ranges. Specifically, for Health Informatics subscales ranged from 3.08 (Data Quality and Interoperability) to 3.52 (EMR and Clinical Decision Support). The overall Health Informatics Total mean of 3.31 with the standard deviation of 0.42 was obtained. Also, management strategies subscales demonstrate mean scores ranging from 3.33 (Resources and Compliance) to 3.74 (Policies and Protocols). Further, an overall management strategies comprising total mean of 3.53 with SD of 0.39 was also reported. Moreover, the integration effectiveness mean score was 3.44 with SD= 0.41.

The aforementioned results indicated that respondents generally perceived moderate to moderately high levels across all constructs. More specifically, scores were clustering around the scale midpoint that is 3.0 to slightly above. In addition, policies and protocols received the highest mean rating among all subscales, whereas Data Quality and Interoperability received the lowest.

Table 3: Descriptive Statistics for Subscales

Subscale	**Mean**	**SD**	**Range**
HI: EMR & CDS	3.52	0.64	1.80-5.00
HI: Surveillance	3.33	0.69	1.80-5.00
HI: Data Quality	3.08	0.74	1.40-4.80
Health Informatics Total	3.31	0.42	2.13-4.53
MS: Policies	3.74	0.65	1.50-5.00
MS: Training	3.51	0.65	2.00-5.00
MS: Resources	3.33	0.71	1.50-5.00
Management Total	3.53	0.39	2.50-4.50
Integration Effectiveness	3.44	0.41	2.30-4.40

4.4 Factor Analysis

Exploratory factor analysis was also performed in order to examine the underlying structure of measurement instruments. The Kaiser-Meyer-Olkin measure of sampling adequacy was computed as 0.789 thereby confirming meritorious factorability. In addition, Bartlett's test of sphericity was also performed and provided t-statistics as $\chi^2 = 3539.77$, p<0.001. From this perspectives, it can be confirmed that correlation matrix was appropriate for factor analysis. Principal axis factoring with varimax rotation extracted seven factors with eigenvalues greater than 1.0 explaining 41.1% of total variance. Hence, the factor structure supports the theoretical subscale organization with items loading mainly on their intended factors.

4.5 ANOVA Results: Role-Based Differences (Hypothesis 1)

One-way ANOVA was also performed to examine differences in scale scores across professional roles. Table 4 demonstrates significant differences exists for Health Informatics having t-statistics as F (4, 345) = 5.290, p < 0.001. For integration effectiveness, t-statistics were obtained as F (4, 345) =21.157, p< 0.001. No significant differences were observed for Management Strategies Total (F (4, 345) = 0.384, p = 0.820). Post-hoc analysis with the use of Tukey HSD showed that IPC specialists reported higher Health Informatics Total scores significantly than administrators (mean difference = 0.281, p=0.009), nurses (mean difference=0.281, p<0.001), other professionals (mean difference = 0.377, p=0.003), and physicians (mean difference=0.298, p< 0.001). In Integration Effectiveness, IPC specialists had significantly higher scores compared to all other groups of professionals (all p<0.001) with the highest difference in IPC specialists in comparison to physicians (mean difference=0.586). The findings testify to Hypothesis 1, which implies that the image of integration

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effectiveness varies greatly depending on the professional roles, with IPC specialists showing the most integration perceptions, as shown in Table 4.

Table 4: One-Way ANOVA Results by Professional Role

Variable	F	p	Result
Health Informatics Total	5.290	<0.001	Significant
Management Total	0.384	0.820	Not Significant
Integration Effectiveness	21.157	<0.001	Significant

4.6 Correlation Analysis

Pearson correlation was used to determine the relationships between the key study variables, as shown in Figure 1. The correlation between Health Informatics Total and Integration Effectiveness was moderate and positive ($r= 0.372$, $p< 0.001$). Another highly positive correlation was found between Management Strategies Total and Integration Effectiveness ($r=0.254$, $p< 0.001$). It is interesting to note that the Health Informatics Total and Management Strategies Total did not have significant relationship with each other ($r =-0.005$, $p=0.931$), which implies that the constructs are different. These data are in favor of Hypothesis 2.

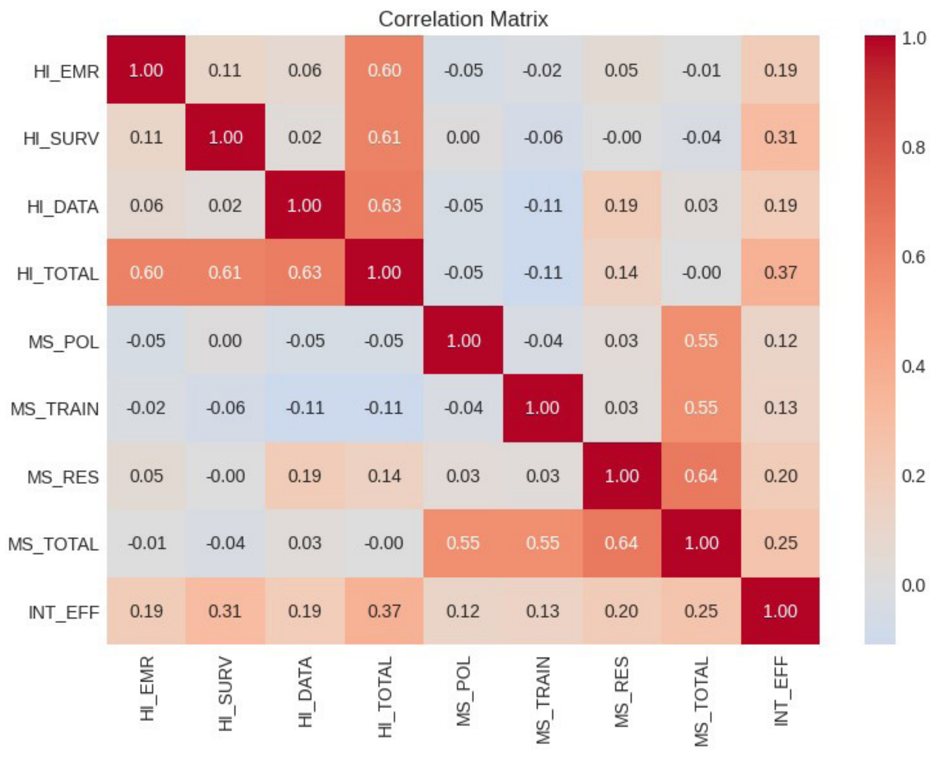

Figure 1: Correlation Heat-map

4.7 Multiple Regression Analysis

There was the use of multiple regression analysis to determine predictors of Integration Effectiveness. The regression results are indicated in Table 5. The model was statistically significant ($F (2, 347) = 44.33$, $p<0.001$) with Health Informatics Total and Management Strategies Total accounting 20.4% of variance in Integration Effectiveness ($R2=0.204$, Adjusted $R2= 0.199$). Both predictors had a significant unique contribution: Health Informatics Total ($\beta= 0.360$, $t = 7.78$, $p < 0.001$) and Management Strategies Total ($\beta = 0.268$, $t = 5.34$, $p < 0.001$). Health Informatics was found to be the better predictor according to the standardized coefficients. The Durbin-Watson (2.055) was not significant (0.055) to suggest that there was a significant autocorrelation in the residuals.

Table 5: Multiple Regression Analysis Predicting Integration Effectiveness

Predictor	B	SE	t	p
Constant	1.300	0.235	5.53	<0.001
HI Total	0.360	0.046	7.78	<0.001
MS Total	0.268	0.050	5.34	<0.001

Note: R^2 = 0.204, Adjusted R^2 = 0.199, F (2, 347) = 44.33, p < 0.001

4.8 Path Analysis

The results of the regression were validated by path analysis, showing that both Health Informatics Total (β = 0.360, p< 0.001) and Management Strategies Total (β = 0.268, p<0.001) directly affect Integration Effectiveness. The model accounted 20.4% variations in outcome variable which were in line with the multiple regression findings. These results are in line with the proposed theoretical model that established the relationship between the health informatics and management strategies and integration effectiveness.

5. Discussion

This paper has explored the perceptions of healthcare workers regarding health informatics and strategy integration of management approach to HAI control in Saudi hospitals. The results are empirical proof of two hypotheses and also give an insight into the factors affecting integration effectiveness. In terms of Hypothesis 1, it was evident that significant differences in the perceptions concerning the effectiveness of integration were observed in different professional roles with IPC specialists reporting the highest scores. The observation is consistent with the professional expertise, as well as the direct participation of IPC professionals in the process of infection control, which probably gives them more contact and understanding of integrated approaches (Zingg et al., 2015). The comparatively low scores among the nurses and physicians could be explained by the fact that they are more concerned about direct patient care and less informed about administrative and technological integration mechanisms.

The fact that Hypothesis 2 was supported means that health informatics capabilities, as well as management strategies, are relevant in integration effectiveness. It is also worth noting that health informatics became the more potent predictor, which implies that technological infrastructure and capabilities could be especially significant in bringing integration. Nevertheless, the contribution of the two predictors alone highlights the need to consider them both at the same time as opposed to concentrating on a single field, be it technology or management. It is worth noting that the total score of health informatics and management strategies is not correlated with each other, indicating that these are two different organizational capabilities that are not necessarily mutually co-occurring. The companies might perform well in one area and poor in the other, which indicates that they should be evaluated holistically and work on the necessary changes.

These results are consistent with other studies which focus on the need to combine technological and organizational variables to achieve successful infection control. Kruse et al. (2018) also observed that to achieve successful health IT implementation in infection control, workflow integration and organizational support are essential areas to be considered. The leading position of IPC specialists in the perception of the effectiveness of integration justifies. Saint et al. (2019) who highlighted the necessity of targeted infection prevention staff to push the quality improvement. The moderate correlation between health informatics and integration effectiveness (r = 0.372) is aligned with Cresswell and Sheikh (2013), who discovered that the use of technology is not enough to result in intended outcomes without the adequate adjustment of the organization. The fact that even management strategies play a significant role in this finding is a good support to the sociotechnical viewpoint that is proposed by these writers.

These results have a number of implications to health care administrators and policymakers in practice. To begin with, the process of enhancing the control of HAI should focus on both the management strategies and the health informatics capabilities. Technological investment without policies, training, and resources attention could give sub-optimal results. Secondly, the views of the IPC specialists should be used in creating and executing the integration efforts based on their detailed knowledge of technological and management aspects. Interprofessional teams which involve IPC knowledge and IT and administrative staff can be especially effective. Third, the conclusion that data quality and interoperability are the lowest rated subscales of health informatics implies an area of improvement that should be done. The importance of interoperability and the quality of data could be improved to increase the usefulness of informatics systems in infection control decision-making.

6. Strengths and Limitations

This paper has a number of strengths such as a heterogeneous sample and various professional jobs and hospital types, acceptable reliability of measurement tools, and thorough statistical analysis with multiple modes of analysis. A niche on the Saudi Arabian context deals with a gap in the literature on integration in developing healthcare systems. Nevertheless, shortcomings should be admitted. The cross-sectional design does not allow causal inferences. There is a possibility of social desirability and recall bias in self-report measures. The unitarist approach restricts the extrapolation to other healthcare settings. The future studies ought to use longitudinal research in order to study the temporal associations and the effect of interventions.

7. Conclusion

This paper shows that health informatics competencies as well as management practices have a strong predictive value in integration effectiveness in HAI control, and professional role moderates perceptions. The measures that healthcare institutions ought to consider to ensure they maximize the effectiveness of infection prevention are holistic strategies that consider both the organizational and technological aspects. ICP experts would be good resources to lead the integration efforts, since they have the overall knowledge of these fields.

Declarations

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Conflict of Interest:

The corresponding author on behalf of all authors asserts that they do not have any conflict of interest.

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