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# A CROSS-SECTIONAL SURVEY STUDY WAS CONDUCTED TO EVALUATE CLINICAL PHARMACIST'S KNOWLEDGE, ATTITUDES AND PRACTICES (KAP) REGARDING ARTIFICIAL INTELLIGANCE AND MACHINE LEARNING

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## ABSTRACT

**Background:** Healthcare systems and the clinical pharmacy profession are greatly influenced in many ways by the use of artificial intelligence (AI) and machine learning (ML), e.g. through improvement of various areas such as drug safety, clinical decision-making, drug monitoring and the development of personalized medicine. In order to ensure that clinical pharmacists can provide effective pharmaceutical care using these new technologies, it is essential that they constantly evaluate their practice as technology becomes available. However, there is little research regarding the knowledge and attitudes of clinical pharmacists currently working in India toward the use of AI and ML in practice. Therefore, it will be important to conduct more focused research, training and education about these topics so that pharmacists are adequately prepared to use these technologies in their practice.

**Objective:** This project set out to evaluate "clinical pharmacist's" knowledge, attitude and perception of employing machine learning (ML) and Artificial Intelligence (AI) in practice as a means of identifying barriers to implementing/using those technologies. In particular we focused on hospital-based clinical pharmacists in order to understand their current understanding and use of AI and ML.

**Methodology:** A validated, 30-item questionnaire covering knowledge, attitude, and perception (10 items each domain) was used for descriptive cross-sectional research with 75 clinical pharmacists working in hospitals located in Telangana, India. Data was collected for 3 months, and analysis was performed through SPSS v25.0 using various tests like chi-square and descriptive statistics. Clinical pharmacists were subjects of another similar questionnaire-based survey that included demographic and KAP-related questions. There were between 50-100 participants, and the survey was distributed online and offline. Descriptive statistical techniques, such as percentage and frequency distributions, were used during the analysis.

**Result:** The survey results indicate that of the 75 respondents, 68% were already knowledgeable about artificial intelligence (AI) and machine learning (ML) as they pertained to pharmaceuticals. Most believed that AI could help to make medications safer or improve how they perform in relation to clinical judgment. Additionally, a remarkable 82% of respondents also stated that they would be willing to utilize AI for work-related purposes. Some obstacles to adoption were inadequate institutional infrastructure (59%), issues with privacy (64%), or a lack of formalized training (78%). In addition, there was a statistically significant relationship ($p < .05$) between participants' perceptions of their understanding of both AI and ML relative to their experience. Overall, pharmacists tended to demonstrate a moderate-to-high level of familiarity with both AI and ML, therefore increasing the likelihood that they could contribute to improving medication safety and reducing the number of prescription-related errors.

**Conclusion:** Many of clinical pharmacists support the application of AI and ML as tools at work; however, to allow for the use of these tools, institutions must provide support through structured educational programs. In order to develop these skills, the training and education project on continued improvement of pharmacists' education to incorporate AI/ML skills into pharmacy curricula will require collaborative efforts by pharmacy schools and educational support agencies.

**KEYWORDS:** Pharmacy practice, integration, institutional support, clinical, artificial intelligence, machine learning, medication safety.

## INTRODUCTION

AI and ML are changing the way we think about health care, especially in terms of patient safety and drug therapy outcomes through the use of machine learning (ML) for data-driven decision-making and the use of AI to imitate human intelligence [1]. Clinical pharmacists

play a critical role in using these technologies to decrease errors with prescriptive medication and improve patient adherence to prescribed medication regimens [2]. However, despite their promise, AI/ML technology has experienced barriers to implementation in pharmacy practice such as lack of knowledge and training of pharmacy professionals and ethical concerns [3]. The objective of this study is to assess the knowledge, beliefs, and behaviors of clinical pharmacists related to AI/ML to inform training and policy development, especially where clinical pharmacy practices are still evolving [4].

**AIM**

The purpose of the study is to assess hospital clinical pharmacists' knowledge, attitudes, and practices regarding artificial intelligence and machine learning.

**OBJECTIVE**

The primary purpose of this study is to review clinical pharmacists' knowledge attitude and perception (KAP) toward the use of artificial intelligence (AI) and machine learning (ML) with an emphasis on clinical pharmacy.

The secondary objectives are to: a), Identify factors that clinical pharmacists perceive as impediments to use of AI/ML in hospital-based pharmacy practice.

b). to analyze associations between KAP and demographic variables such as age, years of practice, and credentialing level.

c). recommend evidence-based initiatives for enhancing AI/ML training within the scope of both pharmacy professional practice and education.

d). assess clinical pharmacist KAP regarding how AI and ML are currently employed within pharmacy practice.

e). identify clinical pharmacist KAP regarding how they utilize AI and ML within current management of patient care.

f). determine barriers that prevent AI and ML from being utilized fully within clinical pharmacy practice.

**MATERIALS AND METHODS**

**Design of the study**

A cross-sectional questionnaire survey assessed how clinical pharmacists at one particular time understood their own level of knowledge, attitudes, and practices (KAP).

**Research location duration of time**

This study was conducted in a number of different hospitals located across Telangana, India. Hospitals included in this study are Tertiary Care, Teaching and Multi-Specialty Corporate Hospitals. Data were gathered over a three-month period for the purposes of this study.

**Research population**

To be part of the study, clinical pharmacists must have a pharmacy license (typically either a B-pharm or PharmD degree), will need to work in a hospital setting, have at least six months of experience in a clinical pharmacy, and agree to provide informed consent for their participation in the study.

**Sample amount**

The sample size was computed using the formula calculating proportions, n = Z (2) pq/d (2). Where q was computed as 1 – p (the proportion not having adequate information) = 0.50. d is the error tolerance that the study can have before it is no longer valid = 0.10 (10%); Z for the confidence level being used = 1.96 = 95%; and p being the overall proportion of those having appropriate knowledge = 0.50. p was calculated with the assumption that there had not been any Indian data on the knowledge of individuals regarding HIV. Convenience sampling allowed for 75 people to be enrolled into the pilot study when the minimum calculated sample size was 97. The final number of participants would be between 50 and 100.

**Study Duration**

In order to achieve the research goals, a variety of observations and analyses were conducted during the course of the three-month study.

**Criteria for inclusion and exclusion**

- Clinical pharmacists are utilized by hospitals.
- Pharmacists have the option to participate if interested.
- To qualify to participate, pharmacists must be over 21 and complete their answers completely.
- Some completed surveys lack all required answers.
- Some pharmacists may not wish to take part in the survey.

**Study instruments**

The team who worked on the study found a way to develop a standardized, self-administered questionnaire through extensive literature review and analysis of previously validated instruments from KAP research conducted on AI in healthcare.

The questionnaire will consist of four main components:

- Sections that contain demographic data
- Questions related to knowledge
- Questions relating to attitudes
- Questions about practices

**Data gathering methods**

Pharmacists were involved in a pilot-study designed to assess the face validity and intelligibility of the questionnaire (i.e., was it clear? was it understandable?); Cronbach's alpha was used to assess internal consistency (i.e., how well the items related to each other; threshold for acceptable internal consistency: $\alpha > 0.70$). The attitude and perception score (i.e., how the pharmacist feels about and perceives the pharmacist's practice) was categorized as either negative, neutral, or positive based on the {In-text citation}; knowledge was categorized as being poor (0-4), moderate (5-7), or good (8-10). Participants in this study could provide informed consent to participate; participants were informed of the purpose of the study and how the findings may impact pharmacy practice before participating. The questionnaires were distributed through Google Forms as well as hard copies.

**Table-1**

| Section | Domain | Content description | No of items | Scoring methods |
|---|---|---|---|---|
| A | Demographic profile | Age, gender, qualification (B.Pharm / M.Pharm / Pharm.D), years of clinical experience, type of hospital (tertiary / teaching / multi-speciality), designation, department, state of practice | 8 items Categorical & continuous | Descriptive — no score assigned |
| B | Knowledge assessment | Definitions of AI & ML; applications in drug discovery, ADR prediction, CDSS, and drug interaction detection; awareness of AI tools used in pharmacy | 10 items True / False / Don't know | 1 = Correct \| 0 = Incorrect Max score: **10** Poor: 0–4 \| Moderate: 5–7 \| Good: 8–10 |
| C | Attitude assessment | Willingness to adopt AI tools; perception of AI as a threat vs. support to professional role; confidence in using AI-assisted CDSS; openness to AI-based training | 10 items 5-point Likert scale | 1 = Strongly disagree → 5 = Strongly agree Max score: **50** Negative: <30 \| Neutral: 30–39 \| Positive: ≥40 |
| D | Practice assessment | Current level of AI/ML training received; preferred mode of learning (workshops, online | 5 items 5-point Likert scale | 1 = Strongly disagree → 5 = Strongly agree |

| | | | | |
|---|---|---|---|---|
| | | courses, in-service training); institutional support availability; self-assessed readiness for AI integration | | Max score: **60** Negative: <36 \| Neutral: 36–47 \| Positive: ≥48 |

**Statistical evaluation**

Descriptive statistics, including the mean ± SD, frequency, and percentage, were employed to perform data analysis using both IBM SPSS Statistics v25.0 and Microsoft Excel. The association between categorical variables was calculated using the Chi-square test; a statistically significant association is defined as a p-value <0.05. The data analysis results are presented in tables and diagrams.

**Ethical issues**

Before data collection, consent from every participant was sought in writing, and ethical approval was obtained from the Institutional Ethics Committee of Malla Reddy College of Pharmacy. Throughout the study, confidentiality was ensured by anonymizing replies and securely storing data. Participation was entirely voluntary.

**SURVEY QUESTIONS**

**Section A - Demographic Data Gathering**

Age:

Gender:

Position:

Years Employment:

Hospital Type:

Division:

**Section B - Knowledge Questions**

1. Have you heard of AI for health care uses?
2. Are you aware of how machine learning works in pharmacy?
3. Have you heard of AI Clinical Decision Support Systems?
4. Do you think AI can help reduce errors when giving medications?
5. Would AI be able to improve the monitoring of medication ADRs?

**Section C - Attitude Questions**

1. Do you think AI could help with providing better patient care?
2. Will Pharmacy Schools need to teach AI technology?

3. Would you like to learn more about AI technologies?

4. Do you believe that AI will help pharmacists in the future?

5. Do you believe that AI could take the place of pharmacists?

**Section D - Behavioural Questions**

1. Has your practice had any AI based software?

2. Have you completed any AI related training.

3. Does your hospital have electronic Clinical Decision Support Systems?

4. Have you used AI tools to review medications?

5. What challenges do you see with implementing AI in your practice?

## RESULTS

### Features of the population

75 clinical chemists participated in the study; 58.7% were female, and 52% were aged 25-34. 64% possessed a Doctor of Pharmacy (PharmD), 48% had between 1-5 years of clinical experience, and 56% worked in an acute care environment.

**Table-2**

| Demographic Variable | Category | n (%) |
|---|---|---|
| **Gender** | Male | 31 (41.3%) |
| | Female | 44 (58.7%) |
| **Age Group (years)** | 20–24 | 14 (18.7%) |
| | 25–34 | 39 (52.0%) |
| | 35–44 | 16 (21.3%) |
| | 45 and above | 6 (8.0%) |
| **Qualification** | B. Pharmacy | 14 (18.7%) |
| | M. Pharmacy | 13 (17.3%) |
| | Pharm.D | 48 (64.0%) |
| **Years of Experience** | <1 year | 10 (13.3%) |
| | 1–5 years | 36 (48.0%) |
| | 6–10 years | 20 (26.7%) |
| | >10 years | 9 (12.0%) |
| **Hospital Type** | Tertiary Care | 42 (56.0%) |
| | Teaching Hospital | 21 (28.0%) |
| | Multi-speciality | 12 (16.0%) |

### Assessment of knowledge

The overall mean knowledge score of the participants regarding AI/ML in pharmacy was estimated as 6.4 ± 1.8 out of 10. A little less than one-fifth (17.3%) of the participants exhibited strong knowledge, with slightly over one-seventh (14.7%) exhibiting low knowledge; however, a substantial portion of (68%) had moderate levels of knowledge. The

relationship between the number of years of clinical practice and the knowledge ratings was statistically significant ($\chi^2 = 14.32$; $p = 0.003$) suggesting that more experienced pharmacists had a greater understanding of AI and ML in pharmacy. The majority (75%) of participants reported being aware of AI related applications and uses within clinical pharmacy, and a much higher percentage (82%) identified uses of AI in healthcare as a whole.

**Table-3**

| Knowledge | Score range | n (%) |
|---|---|---|
| **Poor** | 0-4 | 11 (14.5%) |
| **Moderate** | 5-7 | 51 (68%) |
| **Good** | 8-10 | 13 (17%) |

**Assessment of attitude**

The average score for attitude towards the integration of artificial intelligence (AI) and machine learning (ML) into pharmacy practice was 38.6 (out of 50) and 82.7% of the respondents had a positive attitude about the use of these technologies in their work as pharmacists. Important findings from this study included that 88% of respondents believed that the use of AI/ML in pharmacy practice would lead to better medication safety and that 79% of participants believed that the use of AI/ML would reduce the burden on pharmacists; however, 43% of respondents expressed concerns regarding the impact on their professional autonomy. The majority of participants in this study supported the introduction of AI/ML into practice as a method to improve clinical decision-making and improve medication safety.

**Table-4.**

| Attitude statement | Response category | n (%) |
|---|---|---|
| **Positive general opinions regarding AI and ML (Artificial Intelligence and Machine Learning) developments within the PHARMACY PRACTICE area.** | Positive attitude | 62 (82.7%) |
| **AI/ML will help IMPROVE DRUG SAFEY through clinical pharmacy practice.** | Agree / Strongly agree | 66 (88.0%) |
| **Chemist workload, through technology, will be reduced by AI.** | Agree / Strongly agree | 59 (79.0%) |
| **AI will IMPROVE PHARMACEUTICAL CLINICAL DECISION MAKING and SAFE PRACTICE OF PHARMACY.** | Agree / Strongly agree | 61 (81.3%) |
| **PHARMACY PRACTICE ENVIRONMENTS SHOULD PROMOTE THE INCLUSION OF AI/ML.** | Agree / Strongly agree | 63 (84.0%) |
| **Chemists will be less able to INDIVIDUALLY PRACTICE due to AI.** | Concern expressed | 32 (43.0%) |
| **Chemists may be REQUIRED TO DISPLACE THERAPEUTICALLY from the use of AI in practice settings.** | Agree / Strongly agree | 20 (26.7%) |

**Practice evolution**

Interviews revealed that just 35% of participants had actually used AI-based Healthcare Systems. Poor infrastructure and training put up significant barriers. There was a positive response regarding AI/ML in clinical pharmacy as 74.7% had a score of over 44.1 out of 60 on AI/ML. The greatest benefits of using AI/ML include improved ADR identification (81.3%), improved clinical decision support (77.3%), and improved monitoring of patient medication adherence (72.0%). The most significant barriers are lack of training (78.7%), concerns regarding data privacy/protection (64.0%) and poor infrastructure (58.7%).

**Table-5.**

| Practice session | n | Percentage (%) |
|---|---|---|
| **Absence of official AI/ML training** | 58 | 77.45% |
| **Privacy issues with patient data** | 49 | 63.0% |
| **Inadequate institutional framework** | 43 | 58.4% |
| **Opposition to workflow changes** | 37 | 55% |
| **Concerns about algorithmic bias** | 30 | 40.3% |
| **Fear of AI taking jobs** | 28 | 36% |

## DISCUSSION

The investigation looked at the knowledge, attitudes, and practices of clinical chemists regarding (ML) machine learning and (AI) artificial intelligence in the country of India [5]. The mean knowledge score for all participants was 6.4 out of a possible score of 10, suggesting that there is limited awareness among the participants about the application of AI within the healthcare sector [6]. Eighty-two-point seven percent of all participants had a positive opinion towards AI as a technology; however, there were several gaps in knowledge on this topic which could be attributed to a lack of formal education and training (78.7% felt this was a barrier) [7]. The data provide correlation between levels of knowledge and level of experience, indicating a need for increased continued professional development. Concerns raised about professional autonomy (43%) and data privacy (64%) must be addressed. To advance the generalisability of the paper's outcomes, the authors recommend expanding research to larger and more diverse sample sizes, and investigating the inclusion of AI education in pharmacy curricula.

## CONCLUSION

According to the study, clinical chemists in Telangana, India, display positive attitudes towards AI/ML, but there are limited understanding and difficulties to introducing clinical AI technology in clinical pharmacy practice. Most clinicians believe that barriers to the use of

clinical AI/ML technology in practice include the availability of adequate training and data privacy concerns, which will ultimately hinder successful implementation. The findings of this study indicate that there is a significant need for continuing education opportunities for all professional chemists and for AI/ML integration into PharmD and postgraduate pharmacy education. To fully develop the use of AI/ML capabilities, it is also critical to invest in AI technology infrastructure, strong data governance, and communicate clearly regarding the supportive application of AI in clinical pharmacy roles. Overall, the development of improved professional development, institutional support, and educational programs is key in overcoming the barriers.

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