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Review

Informatics and Artificial Intelligence Approaches that Promote Use of Integrative Health Therapies in Nursing Practice: A Scoping Review

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Abstract

Integrative health (IH) therapies are increasingly used to manage health conditions, but barriers hindering nurses from offering IH therapies persist. Informatics and artificial intelligence (AI) approaches have potential to promote nurses' professional use of IH therapies. The purposes of this review are to (1) describe the state of the science of informatics and AI approaches promoting nurses' use of IH therapies and (2) identify gaps in literature for future investigations. This systematic scoping review followed the systematic review guideline published by the Centre for Review and Dissemination. Five databases were used to retrieve relevant literature published between 2008 and 2018. Sixteen articles describing fourteen studies met predefined eligibility criteria and were reviewed. A descriptive numerical summary method and thematical analysis were used to synthesize the included literature. A fourfold typology emerged to label the informatics and AI approaches, including robots with AI, computer- and mobile-based applications, electronic

communication using an information system, and information standards and standardized terminologies. The reviewed studies suggested that informatics and AI approaches could enhance the safety, accessibility, and communication of nursing IH therapies, as well as enable nursing IH data for IH-related knowledge discovery. Several gaps for future research were identified. There is a need of theory-informed research with more rigorous design and a larger scale to provide robust evidence for implementing existing applications and future innovations. Literature suggests progress toward use of informatics and AI approaches to support nurses' professional use of IH therapies. Further high-quality and theory-informed research is needed regarding the applications used in conventional healthcare in supporting nurses' use of IH therapies.

Keywords
Integrative health; informatics approach; artificial intelligence; nursing

1. Introduction

Integrative health (IH) therapies are increasingly utilized as non-pharmacological and patient-centered strategies for managing health conditions. Integrative health therapies are whole person, person-centered, and relationship-based approaches encompassing biomedical and non-biomedical therapies based on scientific evidence for optimal health and well-being [1, 2]. Surveys indicated that the prevalence of IH therapy use among adults was 33.2%, 25.9%, and 63.1% in the U.S., European countries, and Australia, respectively [3-5]. Integrative health therapies are especially sought by patients with chronic conditions for preventing future health problems, expanding treatment options, and maximizing well-being [6-8]. Integrative health therapies have been recommended for managing several health conditions, such as pain, anxiety, and unpleasant side effects of biomedical therapies [9-11]. Numerous healthcare institutions have started programs to provide conventional Western medicine in conjunction with IH therapies [12, 13].

Nurses, as a healthcare profession embracing a holistic approach, play a central role in the integration of conventional medicine and IH therapies in clinical contexts [12, 14]. Studies have shown that nurses are more positive towards IH therapies and willing to learn and offer IH therapies than other professionals [15]. A systematic review reported that 65.9% of nurses, on average, offered IH therapies to their patients [15]. However, research has also revealed several barriers preventing nurses from offering IH therapies. Common themes include lack of knowledge, training, evidence, reliable sources of information, supportive facilities, peer support, time, regulations, and reimbursement [16-19]. Considerable efforts have been invested in promoting nurses' professional use of IH therapies [20]. Informatics and artificial intelligence (AI) approaches have potential to facilitate nurses' professional use of IH therapies through improving information management, supporting care, and capturing care for outcome evaluations [21-23].

1.1 Health Informatics Approach

Health informatics is a scientific discipline that integrates health, computer, information, and analytic science to facilitate and support healthcare delivery through managing and communicating data, information, knowledge, and wisdom [24]. Informatics approaches include diverse information- and technology-based innovations that assist healthcare professionals with data collection and processing information for problem-solving, knowledge development, and decision making [24]. Informatics approaches, such as electronic health records (EHR), standardized terminologies, online computer applications, and wireless tracking devices, were highlighted as useful tools for promoting IH therapies use in nursing [25].

The EHR is a promising tool to enhance the quality of nursing documentation and enable nursing data to be used in knowledge discovery and care quality improvement [26, 27]. For instance, Johnson and colleagues [28] examined the effectiveness of nurse-delivered aromatherapy in a tertiary hospital using nurse-generated data. They concluded that patients' symptoms, including pain, anxiety, and nausea, were significantly ameliorated after receiving the therapy [28]. Another study using EHR data to explore the use of acupuncture for musculoskeletal disorder patients showed the prevalence of adverse events related to the therapies [29]. The findings of these studies demonstrate the potential of EHR data for driving knowledge and promoting use of IH therapies in nursing.

Standardized terminologies further enable sharable and comparable nursing data for secondary use [30]. Standardized nursing terminologies (SNTs) are collections of concepts that represent nursing practice in documentation for communication and evaluation of nursing care [30]. The American Nurses Association (ANA) recognizes twelve SNTs supporting nursing documentation, interoperability of nursing data, and reuse of clinical data [31, 32]. Previous studies demonstrated the feasibility of SNTs in capturing various nursing practices and enabling nursing data for knowledge discoveries [33]. However, the dominant work related to SNTs has focused on conventional nursing practices. A recent study revealed that Systematized Nomenclature of Medicine - Clinical Terms (SNOMED CT) captured only 42% of integrative therapy terms [34]. The results highlighted a need for evaluating and expanding existing SNTs to improve the representation, interoperability, and usability of IH therapy data.

Despite limited attention on SNTs for IH therapies, some infrastructural work has been done to prepare the SNTs to capture nursing IH practice. Many evidence-based integrative care guidelines coded with the Omaha System, an ANA-recognized SNT, were developed as referencing resources for practitioners to guide their use of IH therapies and documentation using the Omaha System [35]. These guidelines demonstrate how the Omaha System can be used to represent nursing IH therapies in a structured manner. With structured IH therapy data, a data-driven approach can be applied to evaluate the use and outcomes of nursing IH therapies for inspiring future research and informing clinical and policy decisions [28, 29, 36, 37].

1.2 Artificial Intelligence Applications

Artificial intelligence is a branch of applied computer science that aims to develop computerized systems and robots to perform tasks that typically require human intelligence [38, 39]. Several AI and robotic applications have been developed to support healthcare-related tasks,

such as AI-aided diagnosis and intervention selections [40]. The techniques have been applied to support professional use of IH therapies. For instance, a robotic application using image recognition techniques was developed to facilitate the localization and stimulation of acupuncture points [22]. Another example is the development of several companion and humanoid robots to facilitate animal-assisted therapies and psychotherapy for patients with cognitive impairments [41]. All these applications demonstrated the applicability of such techniques for promoting use of IH therapies in nursing. Furthermore, researchers have advocated using evidence-informed theoretical frameworks to guide development and evaluation of informatics and AI applications in supporting healthcare [42-44]. Such theory-enhanced AI may improve the quality of applications and related data and outcomes [42-44].

Although the potential of informatics and AI approaches for promoting nursing IH therapies has been illustrated, the accumulative knowledge has not yet been systematically reviewed and synthesized. The purposes of this scoping review are to (1) describe the state of the science of informatics and AI approaches promoting nurses' use of IH therapies and (2) identify the gaps in literature for future investigations.

2. Materials and Methods

The current review followed the systematic review guideline published by the Centre for Review and Dissemination [45]. This review was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Extension for Scoping Reviews [46].

2.1 Search Strategy

A set of predefined keywords was used to search five electronic databases for identifying literature. The keywords included integrative medicine, integrative nursing, complementary therapy, traditional medicine, alternative therapy, holistic nursing, informatics, information technology, data science, electronic health record, artificial intelligence, and robot, as well as the synonyms of these terms. The databases included the Cumulative Index to Nursing and Allied Health Literature (CINAHL), Ovid MEDLINE, Embase, Scopus, and Google Scholar. The Boolean operators and Medical Subject Heading terms were used to combine the keywords in order to maximize the search. An example of the search strategy used to locate literature in Ovid MEDLINE is provided in Table 1. All searches were limited to the literature published in English between 2008 and 2018. The keywords and search strategies were determined with a senior research librarian. In addition, the chapters related to informatics in two textbooks, including the first and second edition of *Integrative Nursing* [21, 25], were reviewed for additional relevant literature. Furthermore, the citations of all included studies were reviewed to retrieve relevant references.

2.2 Study Selection

Abstracts of each study identified in the search were reviewed before being included. A set of eligibility criteria was used to screen each study. Inclusion criteria were: (1) described or evaluated informatics and AI approaches for promoting nurses' use of IH therapies during patient care, (2) original research, (3) focused on adult patient care, and (4) published as a full paper through a peer-reviewed process and in English.

Exclusion criteria were: (1) proposed or discussed an informatics and AI approach that did not promoting nurses' use of IH therapies during patient care, (2) used phone calls, text messages, or emails that were not embedded in an information system to support nurses' use of IH therapies, (3) published as a review paper, comment, conference abstract, editorial article, thesis, or dissertation, and (4) reported in language other than English.

2.3 Data Extraction

A data extraction tool reflecting the review purposes was developed to extract the relevant data elements from the included literature for evidence summary and synthesis. The data elements included authors, year of publication, study setting, research purpose, types of IH therapy, research design, sampling method, design and theoretical foundations of informatics and AI approach, method for the evaluation of the approach, study results (i.e., sample description, benefit of informatics and AI approach), implications, and limitations. An excel spreadsheet was used to organize the extracted data.

Table 1 Keywords and search strategy for Ovid MEDLINE.

Search terms
1. (exp Informatics/ OR exp Information Technology/ OR exp machine learning/ OR exp latent class analysis/ OR exp decision trees/ OR exp Data Science/ OR exp Medical Records Systems, Computerized/) OR (big data or data science or informatic* OR electronic health record* OR electronic OR medical record* OR EHR* OR data mining OR decision tree* OR decision support OR machine learning OR deep learning OR latent class analysis).mp.
2. (artificial intelligence.mp. or exp Artificial Intelligence/) or (Robot*.mp. or exp Robotics/)
3. 1 OR 2
4. (exp *Complementary Therapies/ OR exp Integrative Medicine/ OR exp Holistic Nursing/ OR exp Medicine, Traditional/ OR ((integrative or traditional OR complementary OR holistic OR alternative OR non-pharmacolog* OR non pharmacolog*) adj2 (therap* OR medicine* OR health* OR healing OR modalit* OR nursing OR intervention*)).mp.)
5. Nurs*.mp.
6. 3 AND 4 AND 5
7. limit 6 to (English language and yr="2008 - 2018")
8. exclude (comment OR editorial OR letter or news OR "review" OR "systematic review")

2.4 Data Synthesis

Data from the included articles were synthesized following an analytical framework proposed by Arksey and O'Malley [47]. A descriptive numerical summary method was used to summarize

across the included articles for an overview of the current state and focus of the literature. Further, the studies were thematically organized according to different types of informatics and AI approaches.

3. Results

A total of 1,280 unduplicated articles were screened with title and abstract, and 1,224 articles were excluded according to the eligibility criteria. Fifty-six articles were reviewed with full-text, and 16 articles describing 14 studies were included in the current review. The PRISMA flow diagram of the literature screen is shown in Figure 1.

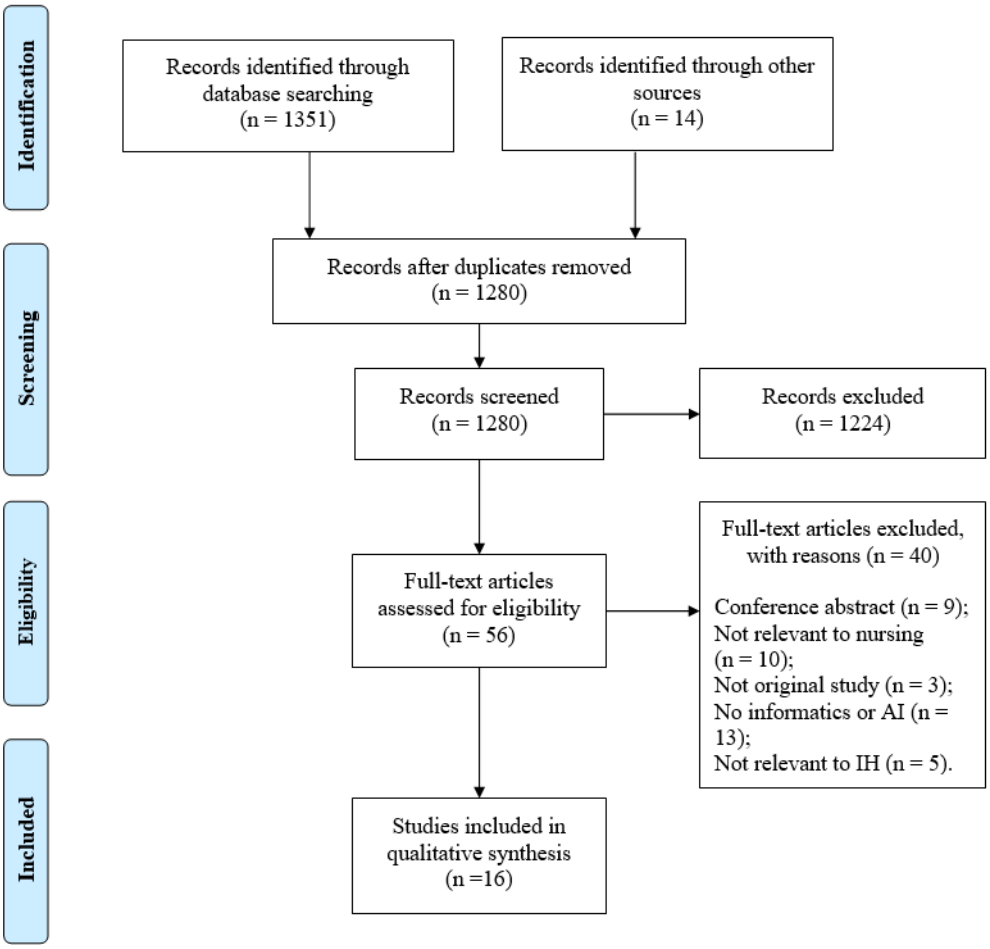

Figure 1 PRISMA flow diagram of study selection.

3.1 Characteristics of Included Studies

The characteristics of the included articles are summarized in Table 2. Of the 14 studies, six used a quasi-experimental design with one group pre-/post-test or post-test only design [48-53], two used retrospective exploratory design [54, 55], two used randomize control trial (RCT) [56, 57], one used cluster RCT [58, 59], one used mixed-method design [14], one used qualitative design [60], and one used cross-sectional design [61]. Most of the studies were conducted in the United States (n= 7), followed by two in Australia, and one each in South Korea, Taiwan, Israel, Norway, and Spain.

For the types of IH therapy discussed in the studies, acupuncture (n=4) and animal-assisted therapy (n=4) were the most frequent IH therapies promoted by informatics and AI approaches, followed by guided imagery (n=2). Other therapies, including herbal and natural products (H/NP), biofeedback, psychotherapy, mind-body therapy, dance therapy, music therapy, acupressure, hypnosis, relaxation techniques, aromatherapy, reflexology, massage, oriental medicine, and traditional Chinese medicine (TCM) were each mentioned in one of the studies.

3.2 Typology of Informatics and AI Approaches

A fourfold typology emerged to label the informatics and AI approaches promoting nurses' use of IH therapies: robots with AI, computer- and mobile-based applications, electronic communication using an information system, and information standards and standardized terminologies. Definitions and examples of each type of informatics and AI approach are summarized in Table 3 and discussed in the following sections.

3.2.1 Robots with AI

The most prominent approach that emerged in this review is robots with AI that can drive the robots to support IH therapies through perceiving environmental changes and automatically adjusting robot actions. Six studies described and evaluated three different robots promoting animal-assisted therapy, psychotherapy, and biofeedback [53, 57-60, 62, 63]. Four studies described the use of companion pet robots that could respond to surrounding stimulations through sound and body movements to support animal-assisted therapy for older adults with dementia or cognitive impairments in long-term care facilities [58-60, 62, 63]. Kramer and colleagues [62] compared visitation programs by a person, a person with a live dog, and a person with a robotic dog for residents with dementia in a long-term care facility. The study suggested that the robotic dog could substitute for live dogs since it provided a higher amount of social interaction stimulation and generated fewer concerns about infection, animal care, and injury [62].

Three studies discussed a companion pet robot with the appearance of baby harp seal [58, 59, 63]. Of them, two RCTs demonstrated the effectiveness of animal-assisted therapy using the robot on maintaining quality of life [59, 63] and decreasing symptoms of depression [58] and agitation [58] among older adults with moderate to severe dementia. One study qualitatively evaluating the robot from therapists' perspectives showed a positive attitude toward offering animal-assisted therapy when used by nurses in their practice [60].

The remaining two studies evaluated humanoid robots supporting psychotherapy and biofeedback [53, 57]. Fulmer et al. [57] applied a psychological AI chatbot to deliver individualized interventions rooted in psychosocial modalities for college students to reduce symptoms of depression and anxiety. Their findings suggested that it is feasible and effective to use the chatbot to deliver emotional support using psychotherapy approaches for reducing depressive symptoms among college students [57]. The second study described a robot with biological sensors to facilitate a biofeedback-based training game for physical and cognitive maintenance for older adults [53]. The robot could move its arms to reflect participants' movements based on the data from a body movement sensor and adjust the difficulty of the game based on heart rate data from another sensor during the game. The study indicated the feasibility and acceptability of the robot in delivering personalized cognitive and motor rehabilitation for older adults [53].

Table 2 Descriptions of the reviewed studies.

Reference	Purpose	Design	Type of IH*	Setting	Informatics and AI approach	Theoretical foundations
Birks et al. (2016) [60]	Explore the use of robotic seal as a therapeutic tool in aged care from the perspective of therapists	Qualitative interview	Animal-assisted therapy	Australia Aged care facility 127 beds	Robotic harp seal with sensors and AI software to learn its name, respond to sound and touch, and express emotions	Approach: NR Evaluation: NR
Boehmer and Karpa (2011) [48]	Determine the degree to which a H/NP* clinical decision tool met clinicians' needs by providing evidence-based information at the point of care	Quasi-experimental design One group pre- and post-test	Herbal and natural products containing plant-based herbals Not including multivitamin products and minerals	United States Medical center 484 licensed beds	Web-based clinical decision support system	Approach: NR Evaluation: NR
Fulmer *et al*. (2018) [57]	Assess the efficacy of integrative psychological AI* on reducing depression and anxiety symptoms	RCT*	Psychotherapy (journaling, CBT*, and emotional support), relaxation strategies, and mindfulness-based therapy	United States 15 universities	Psychological AI chatbot	Approach: NR Evaluation: NR

Gao and Westra (2012) [61]	Evaluate the relevance of CCD* to TCM* practice	Cross-sectional survey	Traditional Chinese medicine	United States NR* in institutional scale	Information standard for IH therapies representation	Approach: NR Evaluation: NR
Griffin *et al.* (2016) [14]	Explore patterns of IH service referrals and the decision-making process	Retrospective exploratory design Qualitative interview	Acupuncture, massage, music, relaxation techniques, acupressure, mind-body therapy, and aromatherapy	United States Tertiary hospital 630 beds	Electronic consultation system for IH therapies referrals	Approach: NR Evaluation: NR
Hou, Chang, and Chen (2015) [49]	Develop an information system for acupuncture treatment Evaluate the system in terms of patient safety, work efficiency, and timeliness of responses	Quasi-experimental design One group pre- and post-test	Acupuncture	Taiwan Medical center 1704 beds in total and 16 acupuncture treatment beds	Acupuncture treatment information system	Approach: NR Evaluation: NR
Hwang and Park (2009) [54]	Explore the representation of the ISO RTM* in Oriental nursing interventions	Retrospective exploratory design	Oriental medicine	South Korea Tertiary teaching Oriental medicine hospital 280 inpatient beds, 7 Oriental nursing care units	Standardized terminology for IH therapies representation	Approach: NR Evaluation: NR

Jallo *et al*. (2017) [50]	Examine the efficacy of mobile-based stress coping intervention for hospitalized pregnant women in high-risk of PTL*, CS*, or PPROM*	Quasi-experimental design One group pre- and post-test	Guided imagery	United States NR* in institutional scale	mHealth-based IH therapy intervention	Approach: NR Evaluation: NR
Jøranson et al. (2015) [58]	Examine the effect of robot-assisted group activity in nursing homes for dementia people on symptoms of agitation and depression	Cluster RCT	Animal-assisted therapy	Eastern Norway 10 nursing homes NR in institutional scale	Robotic harp seal with sensors and AI software to learn its name, respond to sound and touch, and express emotions	Approach: NR Evaluation: NR
Jøranson et al. (2016) [59]	Examine the effect of robot-assisted group activity in nursing homes for dementia people on quality of life	Cluster RCT	Animal-assisted therapy	Eastern Norway 10 nursing homes NR in institutional scale	Robotic harp seal with sensors and AI software to learn its name, respond to sound and touch, and express emotions	Approach: NR Evaluation: NR

Karpa and Boehmer (2012)[51]	Report non-primary care faculty's and nursing staff's use and experience regarding H/NP after using a Web-based clinical decision support system	Quasi-experimental design One group post-test	Herbal and natural products containing plant-based herbals Not including multivitamin products and minerals	United States Medical center 484 licensed beds	Web-based clinical decision support system	Approach: NR Evaluation: NR
Krampe *et al*. (2016) [52]	Evaluate the feasibility and acceptability of a video conference software facilitating a dance-therapy program for older adults	Quasi-experimental design One group post-test	Dance -therapy	United States Assisted living facility NR in institutional scale	Computer-based IH therapy intervention	Approach: NR Evaluation: NR
Kramer *et al*. (2009) [62]	Compare the social behavior of individuals with dementia during a one-on-one visitation by a person, a person with a live dog, and a person with a robotic dog	Quasi-experimental design One group post-test	Animal-assisted therapy	United States Home rehabilitation and health care center NR in institutional scale	Robotic dog with ability to sound, dance, and wave its front legs and AI software to respond to touch with sound and colored light flashing	Approach: NR Evaluation: NR

Lopez-Samaniego *et al.* (2016) [53]	Design and implement a Lego-based robot for cognitive and behavioral maintenance for older adults using biofeedback	Quasi-experimental design One group post-test	Biofeedback	Spain Nursing home NR in institutional scale	Lego-based robot and biological sensors detecting electromyography and heart rate	Approach: NR Evaluation: NR
Moyle *et al*. (2013) [63]	Compare the effect of companion robots on emotions among people with moderate to severe dementia participating in an interactive reading group	RCT with cross-over design	Animal-assisted therapy	Australia Aged care facility 52 low-care and 62 nursing home beds	Robotic harp seal with sensors and AI software to learn its name, respond to sound and touch, and express emotions	Approach: NR Evaluation: NR
Schiff *et al*. (2012) [55]	Explore the meanings and implications of an IH program through analyzing consultation reports associated with the IH service	Qualitative retrospective exploratory design	Acupuncture, reflexology, guided imagery, and hypnosis	Israel Medical Center NR in institutional scale	Electronic consultation system for IH therapies referrals	Approach: NR Evaluation: NR

Notes. * AI: Artificial Intelligence; CBT: cognitive behavioral therapy; CCD: the Continuity of Care Document; CS: cervical shortening; EHR: electronic health record; H/NP: herbal and natural products; IH: integrative health; NR: not reported; PPROM: preterm premature rupture of membranes; PTL: preterm labor; RTM: reference terminology model; RCT: randomized clinical trial; and TCM: traditional Chinese medicine.

Table 3 Description of informatics approaches, example applications, and gaps for future research.

Informatics approach	Description	Selected examples	Gaps for future research
Robots with AI*	Develop, implement, and evaluate robot with AI that can drive the robot to support IH therapies through perceiving environmental changes and automatically adjusting robots' actions	Used a robotic harp seal to facilitate animal-assisted therapy [60] Applied a psychological AI chatbot to support individualized psychotherapy [57]	Attitudes of nursing staff towards robots assisting IH therapy delivery and their impacts on nursing Use of robotic applications in caring children, persons with disabilities, and other populations Comparison of robotic and live pets
Computer-and mobile-based applications	Develop, implement, and evaluate a computer- or mobile-based application to promote or facilitate IH therapies	Developed and evaluated a system for acupuncture treatment [49] Evaluated a web-based herbal and natural products decision support tool [51] Evaluated a mobile application for stress coping [50]	Unintended consequences pertinent to the applications
Electronic communication using an information system	Develop, implement, and evaluate a system to support communication and information sharing between nurses and IH practitioners	Used an electronic consultation system for IH* referrals [14]	Detailed descriptions of IH communication systems for future implementation and improvements Use of electronic communication systems to promote IH communication in other healthcare settings, such as community-based care
Information standards and standardized terminologies	Develop, use, and examine an information standard or terminology to enable thorough, standardized, interchangeable nursing IH therapy documentation in electronic health records	Examined the usability of a pre-existing standardized terminology in presenting Oriental nursing interventions [54] Examined the relevance of CCD data elements to Traditional Chinese medicine practice [61]	Representation of the ANA-recognized SNTs to represent nursing IH therapies

Notes. * AI: artificial intelligence; CCD: the Continuity of Care Document; and IH: integrative health.

3.2.2 Computer- and Mobile-Based Applications

The second type of approach is computer-and mobile-based applications. Four included studies described and evaluated the use of this approach to promote nurses' IH therapy use [48-52]. All studies used a quasi-experimental design with one group pre-/post-test or post-test only to evaluate their applications. Of their applications, one was developed as part of an EHR in a medical center to support clinical use of acupuncture. The study showed that their acupuncture treatment system could enhance patient safety by providing order information at the point of care [49]. Another application that was integrated into an EHR was a web-based decision support tool for the use of H/NP. The tool demonstrated the potential to promote safety of H/NP use by empowering nurses in providing the latest evidence [48, 51].

The remaining two applications were not built as part of an EHR [50, 52]. Of them, one was a mobile-based application for facilitating guided imagery to reduce prenatal stress among hospitalized women at a high risk of preterm birth [50]. In addition to developing new applications, a pre-existing application can be applied to promote IH therapies. Krampe and colleagues [52] applied a pre-existing conference communication software to facilitate a group-based dance therapy for older adults in an assisted living facility. Both applications enabled IH therapies to be delivered remotely and thus potentially enhanced the accessibility of the therapies.

3.2.3 Electronic Communication Using an Information System

Another approach is using electronic communication systems to promote communication and information sharing between nurses and IH practitioners. Two studies described the use and evaluation of this approach [14, 55]. However, both studies provided limited descriptions regarding the use, advantages, and disadvantages of their communication systems. Griffin and colleagues [14] explored the data from the consultation system and conducted qualitative interviews with users in a tertiary hospital. Their findings showed that most nurses and physicians were satisfied with the referral process and remarked that the process worked well and was easy to follow [14]. Authors of the second study thematically analyzed the referral data from a medical center and revealed that an electronic consultation system could facilitate communication between IH practitioners and conventional healthcare providers [55].

3.2.4 Information Standards and Standardized Terminologies

The fourth type of approach is the use of information standards and standardized terminologies. The approach was defined as developing, evaluating, and using information standards and standardized terminologies to enable thorough, standardized, interchangeable IH therapy documentation within EHRs. Of the included studies, one study evaluated the usability of an international standards organization reference terminology model (ISO RTM) in representing Oriental nursing interventions in a tertiary Korean hospital [54]. The findings revealed that a standardized terminology developed from a Western medicine perspective was applicable to represent Oriental nursing interventions and enable future research by providing structured data. The authors also indicated that the use of the ISO RTM decreased granularity in describing Oriental nursing interventions [54].

Another included study suggested that an existing information standard based on the biomedical model could promote the interoperability of IH therapy data. Gao and Westra [61] conducted a cross-sectional survey of IH practitioners regarding the relevance of elements in the Continuity of Care Document (CCD) to IH therapy. The study concluded that most CCD elements are relevant and could be used to capture IH interventions and outcomes for information exchange among healthcare settings. However, the study also suggested that a standardized terminology specifically delineating IH therapies should be developed to complement the CCD for sharing information between conventional and IH practitioners [61].

3.3 Gaps Identified in This Review

Serval gaps in the literature were identified for each approach and are summarized in Table 3. In addition, gaps across the approaches were identified. First, none of the included studies discussed the theoretical foundations of their informatics or AI applications and evaluation design. Furthermore, most studies used an observational design or a quasi-experimental design with a single group and a small sample. There is a need of theory-informed research with more rigorous design and larger scale to provide robust evidence for implementing existing applications and future innovations.

4. Discussion

This review of the literature describes the scope of informatics and AI approaches supporting nurses' professional use of IH therapies to date. The informatics and AI approaches identified in this review were summarized and labeled by a fourfold typology, including robots with AI, computer-and mobile-based applications, electronic communication using an information system, and information standards and standardized terminologies. Informatics and AI approaches may enhance the safety, accessibility, and communication of nursing IH therapies, as well as enable nursing IH data for IH-related knowledge discovery.

The most common type of informatics and AI approach identified in the current review is robots with AI. All studies demonstrated positive results in using AI robots to promote IH therapies. It is notable that there is considerable interest in using robots to support animal-assisted therapy for older adults with dementia and cognitive impairments, consistent with a previous review on the use of robots in nursing [41]. The majority of reviewed studies evaluated their robotic applications from patients' perspectives or outcomes; additional research is needed regarding the attitude of nursing staff towards robots assisting IH therapy delivery [64]. Further, although studies suggested that pet robots can substitute for live animals, none of the reviewed studies compared robotic and live pets from either patients' or therapists' perspectives. Thus, whether robotic pets can replace live animals and bring benefits suggested in the literature [60, 62, 63] is unknown and should be further examined.

The second type of approach is computer- and mobile-based applications. Four studies described three computer-based software and one mobile-based application for facilitating the use of IH therapies by nurses. All demonstrated feasibility of promoting IH therapies, acceptability to clinicians, enhanced safety of IH therapy use, and increased accessibility of IH services. These advantages are consistent with the benefits of using computer- and mobile-based applications in conventional healthcare [65, 66]. However, all four studies used a quasi-experimental design, and

the small sample size and single group design may bias the results [67]. More robust methods to test the applications are needed, such as a larger scale experimental and quasi-experimental design with comparison groups and longitudinal follow-up [68]. Furthermore, unintended consequences pertinent to the applications were not explored. Given that computer- and mobile-based applications could have both positive and negative impacts on clinical practice [69], the negative impacts of the applications have potential to offset their benefits and should be investigated.

The third type was electronic communication using an information system used to support nurses' use of IH therapies. The studies suggested that an electronic consultation system can make the referral smooth and facilitate the communication of patient information and treatments among IH practitioners and nurses. Such improved communication has potential to enable continuity of care, reduce cost by cutting redundant treatment, and improve quality of care [70]. A number of gaps in using the electronic communication system promoting IH therapy communication emerged in this review. First, the primary focus was on analyzing data collected in the systems for discovering knowledge regarding nurses' decision-making and communication in IH referrals. Descriptions of the design, utilization, and benefits of the systems were limited. Second, both studies were conducted in a tertiary setting. The utilization of an electronic communication system to promote IH communication in other healthcare settings is lacking, despite the fact that primary and community-based care practitioners frequently offer IH therapies to their patients and make IH referrals [71, 72]. Whether an electronic communication system can work well for and benefit those care providers needs to be explored in future studies.

The last approach identified in the current review is information standards and standardized terminologies that can enhance the quality, usability, and interoperability of IH therapy documentation. These studies highlighted the need for further development of standardized terminology to support thorough and structured nursing IH intervention documentation. Limited scientific works related to the use of SNTs to enhance IH therapy documentation were identified with the search terms used in this review. None of the reviewed studies examined the representation of the ANA-recognized SNTs in nursing IH therapies. Although use of SNTs to capture IH practice is in its infancy, some work preparing the existing SNTs for documenting IH therapies has been done [21, 35]. However, the majority of those works were presented in books and web sites. The extent to which those works can affect the quality and interoperability of nursing IH therapy documentation in real-world practice is unknown and needs to be further explored in the future.

None of the reviewed articles described the theoretical foundations of their approaches, consistent with previous literature urging the need of theoretical approaches to informatics and AI applications supporting healthcare [73]. Previous research has demonstrated that theories provide frameworks for guiding healthcare technology design, implementation, and evaluation [41-43]. Informatics and AI approaches for nursing IH therapies should also be developed and evaluated based on evidence-informed theoretical frameworks. Several existing theories could be used to advance the science [44]. For instance, the structure-process-outcome quality of care model [74] or the Problem-Intervention-Outcome Meta-Model [31] could provide theoretical foundations for comprehensive and structural examinations of innovative applications regarding their impact on healthcare and patient outcomes.

The implications of this review are many. Evidence suggests progress toward using informatics

and AI applications to address some barriers to nurses' professional use of IH therapies. For instance, AI robots may facilitate numerous IH therapies and facilitate providing both conventional and IH therapies. Lack of IH-related knowledge may be addressed using computer-and mobile-based applications to provide up-to-date knowledge at the point of care. In addition, all approaches identified were used in conventional healthcare, which may suggest that technology used in conventional nursing has potential to promote IH therapies. However, several technologies, such as expert systems and predictive analytics for nursing outcomes research, are not yet applied to support nursing IH therapies and should be scientifically evaluated.

This review has several limitations. First, the search terms for retrieving literature may fail to capture all relevant literature. Integrative health is not consistently defined in the literature, and numerous terms were used to represent IH therapies [75]. Although the search terms for IH therapies were intentionally broad in this review, investigators may describe IH therapies with other terms. The same is true for informatics and AI approaches. In addition, the feasibility of applying advanced AI applications, such as machine learning techniques, to support IH therapies was demonstrated in previous studies [22, 40, 76]. However, none of those techniques appeared in this review. Although this absence could be due to the literature databases and search terms used, it may also be true that advanced AI techniques have not been applied to support nurses' use of IH therapies.

5. Conclusions

The state of the science of informatics and AI approaches that promote nurses' professional use of IH therapies is that Informatics and AI approaches may enhance the safety, accessibility, and communication related to nursing IH therapies, as well as enabling nursing IH data for knowledge discovery. Informatics and AI approaches have potential to accelerate the integration of conventional and IH therapies for enhancing care quality and continuity of care. Further high-quality and theory-informed research is needed to advance use of informatics and AI in supporting nurses' use of IH therapies.

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Author Contributions

All authors contributed to the design of this study. SCL was involved in acquisition of the papers for review and the data from the papers. SCL and KM initially analyzed the data and wrote the first draft of the manuscript. All authors reviewed and edited the manuscript, as well as approved the final version of the manuscript.

Competing Interests

The authors have no competing interests to declare.

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