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# The Impact of Health Technologies on Ostomy Care

A Systematic Review of Health Technologies Impact on Ostomy Care

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# ABSTRACT

**PURPOSE:** The purpose of this systematic review was to evaluate studies in which health information technology was used to improve ostomy care and management.

METHODS: Systematic literature review.

**SEARCH STRATEGIES:** The review was performed according to PRISMA Guidelines. Three scientific databases, Scopus, PubMed, and Web of Science, were searched with no time limitation using key words related to information technology and ostomy. The selection of articles and data collection were carried out by 2 reviewers and disagreements were resolved via discussion with a third, independent reviewer.

**FINDINGS:** The initial search of electronic databases retrieved 1679 elements; following removal of duplicate records, title and abstract review, and articles read in full for inclusion/exclusion criteria, 10 articles were included in the review. Analysis of findings from studies included in our review addresses technologies used to care for persons living with an ostomy. Elements were divided into 2 categories: (1) sensor-based wearable technologies, which were mostly used to assess the fecal output and fullness of ostomy pouching system, and (2) computer-based, tablet based, and smartphones platforms, which were used for teaching and learning. The most significant outcomes were increasing patients' knowledge and awareness of ostomy, enhancing patient's participation in self-care processes, and improving self-efficacy levels.

**IMPLICATIONS FOR PRACTICE:** We found limited research regarding the effectiveness of technology-based interventions on the management of ostomy patients. Findings of this systematic review suggest that the application of technologies has created a positive effect on the management of an ostomy, provided opportunities for enhancing self-efficacy, self-care, and self-management. The results of this study can be a basis for designing efficient technology-based systems for the management of ostomy.

KEY WORDS: Health information technology (HIT), Ostomy, Self-care, Self-efficacy.

## INTRODUCTION

The use of digital technologies is rapidly expanding and has influenced people's personal life and interactions with others.<sup>1</sup> The application of technologies in the field of health care has improved the provision of health services, reduced care and treatment costs, and enhanced the quality of health care.<sup>2</sup> In addition, evidence indicates that health information technologies can improve the efficiency and safety of health care delivery, facilitate diagnosis of diseases and disorders, enhance patient's management and support, increase knowledge and understanding of a patient's diseases, and reduce errors and morbidity or even mortality.<sup>3,4</sup> The advancement of health information technologies has provided approaches that support effective and economical health care services and training. For example, cell phones, computers, emails, and other Internet-based tools have been designed to improve chronic disease management by supporting clinical decision-making support tools that incorporate assessments of disease risk, coupled with applications of guidelines supporting interventions; these technologies have also facilitated patient's self-management via Web portals, telemedicine platforms, and information delivery via email or secure messaging.<sup>5</sup> Health information technologies already incorporate many of the most widely used medical products,

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Ostomy Care." declare that there are no conflicts of interest or financial	DOI: 10.1097/WON.0000000000001021	

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positioning their use as a key component of a well-functioning health system.<sup>6</sup>

Ostomy care may be facilitated by judicious use of health technologies.<sup>7</sup> Preoperative surgical stoma-site marking and creation of a well-functioning ostomy are essential as patients learn to live with an abdominal ostomy.<sup>8</sup> Facilitating the pathway to a new normal following ostomy surgery is complex, and health care providers play a vital role in this challenging process.<sup>9</sup> By 2018, approximately 700,000 people residing in Europe and 750,000 residents of the United States were living with an ostomy.<sup>7</sup> Information technologies have the potential to facilitate ostomy self-management, adjustment to an ostomy, and maintaining a good health-related quality of life.<sup>10</sup>

Although creation of an ostomy is essential in the management of multiple medical conditions, living with an ostomy creates a wide range of physical, social, and psychological challenges influencing social reactions, job considerations, and activities of daily living.<sup>11,12</sup> Living with an ostomy may diminish HRQOL in multiple areas including vitality, physical and social life, and travel.<sup>12,13</sup> Fortunately, these challenges tend to diminish over time as the individual adjusts to a new normal that includes caring for his or her ostomy.

In their systematic review, Recalla and colleagues<sup>14</sup> observed that people living with an ostomy required specialized care and management to maintain their physical health and HRQOL. Additional constitutional factors also contribute to adjustment to life with an ostomy such as a secure financial status, employment, insurance coverage, WOC/Ostomy nurse availability, meeting with a person living with an ostomy after stoma surgery or ostomy support group participation, and learning to prevent or promptly manage stoma and peristomal complications.<sup>12,15-18</sup> Given the potential for information technologies to enhance ostomy self-management, identify stomal or peristomal skin complications, and enhance psychosocial adjustment to an ostomy<sup>1,15-17</sup>, this systematic literature aimed to identify different types of health information technologies that have been applied to ostomy management and identify their influence on improving ostomy management.

### MATERIALS AND METHODS

This systematic review was carried out using PRISMA Guidelines.<sup>18</sup> Inclusion criteria were studies that evaluated the application of information technologies designed for individuals living with any type of fecal ostomy (colostomy or ileostomy) or nurses who take care of these individuals and were included as participants in the studies. Additional inclusion criteria were articles written in the English language, available as a full-text research report. Exclusion criteria included absence of a technology-based intervention or other type of stoma such as a urostomy. No time and place limitations were applied to our search; all articles published until December 24, 2020, were deemed eligible for inclusion.

To search the databases, a list of key words related to ostomy and information technology was determined. The search strategy was developed by 2 researchers (K.H.M. and E.I.) and, finally, approved by the third researcher (L.A.). The key words and search strategy are listed in Table 1. Three electronic databases, Scopus, PubMed, and Web of Science, were searched using related key words; a similar strategy was used to search all 3 databases.

The titles and abstracts of all related articles were retrieved from databases and entered into the Endnote software by a

TABLE 1.   Key Words and Search Strategy <sup>a</sup>				
Key Word Categories	Key Words			
Ostomy related	( <b>Ostomy</b> OR <b>Colostomy</b> OR <b>Ileostomy</b> OR Eternal optimism OR Abdominal stoma OR)			
Information technology	(Information Systems OR E-health OR <u>Information</u> <u>technology (IT)</u> ] OR <u>Smartphone</u> OR <u>Software</u> OR <u>Telemedicine</u> OR <u>Wearable</u> <u>electronic devices</u> OR <u>Mobile applica-</u> <u>tions</u> )			
Search strategy	[(Ostomy related key words) AND (Information tech- nology related key words)]			

<sup>a</sup>Mesh terms are presented in boldface.

single reviewer (K.H.M.). After removing duplicate references, the title, key words, and abstracts of the articles were carefully and independently screened by 2 researchers (K.H.M. and E.I.). All elements that met inclusion criteria were entered into the final review for data extraction and analysis. In the third stage, all relevant articles entered into the final review were reexamined by an independent reviewer for eligibility (L.A.). Data extraction of included studies was undertaken by 2 reviewers using a standardized form (K.H.M. and E.I.). Data extracted were year of publication, country, study purpose and design, number of participants, type of technology or intervention used, measurement tools or instrument, key findings, and authors' conclusions (see Supplemental Digital Content Table 1, available at: http://links.lww.com/JWOCN/A95). The face validity of the data extraction form was reviewed and verified by 2 experts in the field of medical informatics and software engineer. In addition, data extracted from included studies was reviewed and confirmed as accurate by a third, independent reviewer (L.A.).

Initially, 594 articles from the PubMed database, 1002 from the Scopus database, and 83 from the Web of Science database were retrieved. One hundred thirty-eight duplicate elements were then removed. The remaining 1541 elements were narrowed to 10 elements following title and abstract review; the remining 10 elements were then read in full and all were included in the final review (Figure 1).

#### **FINDINGS**

Study findings indicate that researchers from multiple countries have used (and some have developed) health information technology to facilitate ostomy management. Among them, the United States had the most health technology–based activities to control and manage ostomy (40%). Information on other countries is provided in Figure 2. Six of the studies were performed in academic institutions<sup>19-23</sup> and data were collected in an outpatient setting in 3 studies.<sup>19,20,22</sup> Two were randomized controlled trials<sup>16,19</sup> and 2 were pilot studies.<sup>22,23</sup> Two studies were cross-sectional<sup>24</sup> and prospective cohort.<sup>20</sup> The remaining studies were descriptive (nonexperimental) in their design.

Most studies evaluated the effectiveness of a particular technology in participants or respondents living with an ostomy; the goals of these technologies were to improve self-efficacy, self-care, and self-management related to an ostomy. Typically, nurses introduced participants to the technology and assisted them in learning to use the technology being evaluated.<sup>20,24-26</sup>

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Figure 1. Study selection process.

Sample sizes ranged from 9 to 203 participants<sup>19</sup>, the age of participants varied from 18 to 76 years<sup>16,19</sup>, and the most common type of fecal ostomy was ileostomy.<sup>17,24,26</sup> In 4 studies, colostomy and ileostomy complications were evaluated.<sup>19,20,22,27</sup> In 2 studies, the type of complication was not mentioned.<sup>16,24</sup> The maximum follow-up period or treatment duration and the duration of the use of information technology in the studies were 13 months.<sup>21,23</sup>



Figure 2. Countries publishing on the application of ostomy control and management technologies.

We categorized the various technologies used in these 10 studies into 2 categories: sensor-based wearable technologies (n = 1) and information-based technologies displayed on a computer, tablet device, Web-based technologies, or mobile phones (n = 9).<sup>16,17,19,20,22-24,26,27</sup> Supplemental Digital Content Table 1, available at: http://links.lww.com/JWOCN/A95, summarizes the technologies used in each study, Table 2 lists the outcome measures used in each study, and Table 3 outlines study findings.

A single study reported development and clinical evaluation of a sensor-based technology developed specifically for ostomy care. Kontovounisios and colleagues used the Ostom-iAlert Sensor, a wearable sensor-based technology. Developed by 11 Health and Technologies Limited in Borehamwood Herts, United Kingdom, the Ostom-iAlert Sensor is a CE-marked (Conformité Européenne, indicating conformity with health, safety, and environmental protection standards for products sold within the European Economic Area) and FDA (Food and Drug Administration)-approved medical device. This device incorporates a flexible sensor attached to the lower part of an ostomy pouch to detect filling and relay real-time data to the patient through a smartphone application. It records the volume of ostomy output and enables patients to set alerts, potentially preventing pouch overflow and leakage. The collected data can be shared with nursing staff through a dashboard display and has the potential to integrate directly into the patient's electronic medical record. The device boasts 10% accuracy in measuring stoma output volume. Findings indicate that

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TABLE 2.	
Measurement Indexes in Studies	

	Frequency
Effectiveness and efficacy of the health technologies <sup>16,24</sup>	2
Self-efficacy indexes <sup>17,19</sup>	2
Quality of life <sup>26</sup>	2
Patient satisfaction <sup>22,23</sup>	2
Usability	1
Effectiveness of multimedia training programs related to the knowledge of ostomy <sup>16</sup>	1
Reliability and validity of color indicators <sup>20</sup>	1
Self-care indexes <sup>16</sup>	1
Stoma complications incidence <sup>19</sup>	1
Feasibility of the technologies <sup>22</sup>	1
Incidence of complications <sup>19</sup>	1
Quality and content of the provided health services by $technologies^{\rm 27}$	1

this sensor-based technology improved health-related quality of life, reduced hospital length of stay and readmission rate, and enabled nursing staff to attend more patients.

The most widely used platforms for information-based technologies were desktop or laptop computers,<sup>16,17,24</sup> mobile phones, Web-based platforms,<sup>22,23,26</sup> or mobile application.<sup>17,18,20,24,25,27</sup>

IABLE 3. Summary of Study Outcomes				
Outcomes (References)	Frequency			
Increase the knowledge and awareness of patients about ostomy <sup>16,17,24,27</sup>	4			
Patients' increased participation in ostomy self-care processes <sup>16,17,26</sup>	3			
Improve self-efficacy in ostomy management <sup>16,17,19</sup>	3			
Improve health-related quality of life <sup>26</sup>	2			
Remote monitoring of acute complications <sup>22</sup>	2			
Greater freedom and confidence to perform everyday activities <sup>22,24</sup>	2			
Link persons living with an ostomy and their health care providers <sup>22,23</sup>	2			
Improvement of patients' social, physical, mental, and emotional status <sup>19</sup>	1			
Reduce anxiety <sup>22</sup>	1			
Improve quality of ostomy care <sup>20</sup>	1			
Reduce hospital readmission rates	1			
Reduce hospital length of stay	1			
Improve nurses' ability to provide high-quality care <sup>26</sup>	1			
Inform clinician decision making <sup>20</sup>	1			
Reduce rates of stoma and peristomal skin complications <sup>19</sup>	1			
Enhance patient involvement in their stoma care <sup>16</sup>				
Educate nurses regarding pouch application and emptying <sup>24</sup>	1			
Improve self-management processes <sup>22</sup>	1			
Enable nursing staff to attend more patients	1			

Internet search engine technologies were used in 1 study. Some of these technologies such as Web-based technologies,<sup>26</sup> multimedia education program,<sup>16</sup> and computer-based software<sup>17,24</sup> were designed with the aim of teaching patients or nurses about various aspects of ostomy care. Study findings indicated significant improvements in staff nurse confidence and knowledge scores, as well as enhanced ileostomy knowledge, ostomy care self-efficacy, and patient's involvement in self-care.

Table 2 summarizes outcome measures used to evaluate these sensor-based and information-based technologies. Study outcomes were most often evaluated using questionnaires that were designed for the purposes of each study as compared with previously validated instruments.<sup>16,19,22,23,24,27</sup> In addition, several studies evaluated the usability and feasibility of technologies.<sup>22,23</sup> For example, a videoconferencing software in 1 study was evaluated for its ability to enable participants to attend Virtual Postoperative Visits remotely.23 Similarly, the study by Bednarski and colleagues<sup>23</sup> evaluated the feasibility of a telemedicine platform to assess ileostomy output and the need for medical intervention in persons with new ostomies. The study by Iizaka and colleagues<sup>20</sup> evaluated software designed to digital images of the peristomal skin. Findings indicated that the peristomal skin had significantly higher values for these color indicators, enhancing identification of skin discoloration, which correlated with the severity of inflammation and pain scores.

The study by Connelly and coworkers<sup>27</sup> used several Internet search engines to identify Web-based information on intestinal ostomies; the accuracy of this information was validated by a novel scoring systems technology. The researchers used the key words "stoma," "colostomy," "ileostomy," and "bowel bag" into 3 widely used Internet search engines. They analyzed the first 10 Web sites from each search using previously evaluated generic (not specific to ostomy care) benchmark criteria. In addition, they developed and applied a new stoma-specific scoring system.

Table 3 summarizes the outcomes of using these technologies in ostomy care. Based on frequency, the outcomes (1) increase knowledge and awareness of patients about ostomy, (2) increased patients' participation in ostomy self-care processes, and (3) improve the level of self-efficacy were the most important outcomes.

## SUMMARY OF EVIDENCE

Considered collectively, the evidence of these studies suggests that sensor-based and health information technologies have the potential to transform enhanced ostomy care for both patients living with an ostomy and the nurses and other health care providers managing these individuals. These technologies can enhance patient's education,<sup>22</sup> self-management,<sup>26</sup> and self-efficacy.<sup>17,19</sup> They can facilitate remote monitoring and communication and improving multiple patient outcomes and satisfaction with an intestinal ostomy. Ideally, these technologies should be routinely integrated into ostomy care to maximize their benefits across different health care settings. Nevertheless, we assert that there are specific situations or indications in which their use could be particularly beneficial. These include complex ostomy cases, patients requiring intensive monitoring or support, individuals at elevated risk of complications, and patients with limited health care resources. Implementing these technologies judiciously in such scenarios has the potential to optimize their impact on ostomy care.

Should these technologies become commercially available, we foresee their predominant role as enhancing ostomy self-management and self-efficacy. By improving these outcomes, we assert that these technologies have the potential to reduce anxiety, enhance early detection, and prompt management of stoma and peristomal skin complications, ultimately leading to enhanced HRQOL among individuals living with an ostomy. Moreover, information technologies have the potential to reduce readmission rates and hospital length of stay and prevent complications. Evidence summarized in this systematic review also suggests that information technologies also possess the potential to improve WOC/Ostomy nurses' ability to provide high-quality care, enhance rapid communication with patients, and improve clinician decision making.

Additional research is needed to determine the optimal platform for ostomy-related information technologies. For example, despite the increasing use of mobile phones, most of the studies in this review used desktop or laptop computers. Research not included in this review indicates that the screen size of mobile phones may be more difficult for users to read when compared with desktop or laptop computers, especially when the application involves large amounts of information.<sup>28-35</sup> Current best evidence suggests that smaller screens may make some users reluctant to perform more complex tasks whereas larger computer-based screens assist in the accomplishment of such complex tasks.<sup>29,30</sup> Therefore, we recommend development of information technologies for ostomy care that continues to incorporate use of larger computers as compared with mobile phones.

Findings of this systematic review also have implications for WOC/Ostomy nursing practice. Long-term ostomy management is delivered by WOC/ostomy nurse specialists.<sup>31,32</sup> Effective specialist nursing management has been shown to reduce stoma or peristomal skin complications and self-management of and ostomy, thereby enhancing social adaptation and HRQOL.<sup>33-35</sup> For example, Marquis and colleagues<sup>36</sup> valuated the quality of life of 4739 ostomy patients and reported that patients who reported higher satisfaction with their nursing care and had a positive relationship with their nurses experienced significantly higher HRQOL than patients who had no contact with their nurses. Technologies have the potential to enhance WOC/Ostomy care by complementing initial ostomy care education delivered during the pre- or postoperative period following ostomy surgery, bridging physical distances via telemedicine platforms, enhancing diagnostic accuracy via software enhancements of digital photography, and increasing self-management skills and self-efficacy through sensor-worn technologies designed to alert patients to effluent volume in the ostomy pouch.

#### **Gaps in Evidence**

Our experience during this systematic review demonstrated the paucity of studies evaluating sensor-based and information technologies designed to improve ostomy care. We therefore recommend additional research focusing on the use of interactive educational mobile applications on multiple outcomes such as self-efficacy, complication rates, and health resource use and utilization. We also encourage research focusing on the role of sensory technologies on rates of pouch undermining leakage and rates of peristomal skin complications. Further investigation is needed to determine the optimal platform for delivering information via mobile phone, desktop, or laptop computer. Research is needed to

determine the role of in-line technologies for enhancing ostomy care such as social media, texting, or emails. Finally, considering different functionalities when developing ITbased information, we recommend investigation into alternative means of delivering information such as infographics, video, or gaming features, along with reminders and alerts.

## CONCLUSIONS

Findings of this systematic review suggest that sensor-based and health information technologies have the potential for enhancing self-efficacy, self-care, and self-management for individuals living with an ostomy. These technologies also have the potential to improve the quality and effectiveness of long-term ostomy monitoring and management, increase the efficiency of care delivery, inform clinical decision making, increase patient satisfaction, and reduce the costs of care.

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## KEY POINTS

- Sensor-based smart wearable technology has the potential to improve self-care management for patients with an ostomy.
- > Using sensor-based smart wearables and information technology, patients can better manage and control the ostomy and reduce its complications.
- By providing educational and self-care services through health information technologies, the length of hospital stay and the rate of hospital readmissions can be reduced.
- > Sensor-based smart wearables and information technology can improve the physical and emotional health of patients with ostomy.

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