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Evidence Check

Electronic meal ordering systems

An **Evidence Check** rapid review brokered by the Sax Institute for the NSW Ministry of Health. May 2015.

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This report was prepared by:

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MACQUARIE
University

Contents

1 CHSSR Overview

The Centre for Health Systems and Safety Research (CHSSR) conducts innovative research aimed at understanding and improving the way in which health care delivery and patient outcomes are enhanced through the effective use and exchange of information. It is one of three research centres that form the Australian Institute of Health Innovation (AIHI) at Macquarie University.

Mission

The Centre's mission is to lead in the design and execution of innovative health systems research focused on patient safety and the evaluation of information and communication technologies in the health sector, to produce a world-class evidence base that informs policy and practice.

Aims

The Centre's research is underpinned by a systems perspective, which uses highly innovative and wide-ranging research methods. Its research team is characterised by its talent and enthusiasm for working within and across discipline areas and sectors. The Centre has a focus on translational research, aimed at turning research evidence into policy and practice, while also making fundamental contributions to international knowledge.

The Centre's research program has four central aims:

- Produce research evidence of the impact of information and communication technologies (ICT) on the efficiency and effectiveness of health care delivery, on health professionals' work and on patient outcomes
- Develop and test rigorous and innovative tools and approaches for health informatics evaluation
- Design and apply innovative approaches to understand the complex nature of health care delivery systems and make assessments of health care safety
- Disseminate evidence to inform policy, system design, practice change and the integration and safe and effective use of ICT in healthcare.

2 Executive Summary

In 2014, HealthShare NSW commenced the development of a new delivery model for patient food services. A set of nutrition standards for menus and specifications for therapeutic diets was developed by the Agency for Clinical Innovation (ACI) to facilitate centralised menu planning and food production. These standards form part of a broader framework to improve nutritional care in NSW hospitals, including reform to the current paper-based meal ordering system with implementation of electronic meal ordering. The electronic meal ordering system is expected to produce multiple benefits for organisations and patients.

A request was made by the Workforce Planning and Development Branch, at the NSW Ministry of Health, to undertake a literature scan to identify and summarise current evidence regarding electronic meal ordering systems in order to inform the planning and evaluation of the NSW meal ordering system reforms. This report presents findings from an evidence scan of literature, from Australia and internationally, on electronic meal ordering system reforms and their associated impacts on hospital and patient outcomes. The period of the review spanned 15 years, from January 2000 to December 2015.

The objectives addressed by the review were to:

- Describe the types of electronic meal ordering systems and food service reforms related to the introduction of electronic meal ordering systems that have been reported in the literature
- Describe any nutritional screening and risk assessment protocols implemented alongside electronic meal ordering systems
- Present evidence of the impact of electronic meal ordering systems on patient outcomes and on implications for staff, and
- Discuss considerations for future evaluations of electronic meal ordering systems based on the evidence identified in the literature.

Identified literature describing meal ordering and associated food service reforms discussed three categories of electronic meal ordering: (i) the "spoken menu" model; (ii) the "room service" model; and (iii) the "self-service" model. The spoken menu model involves a staff member attending the patient bedside, discussing food options with the patient, assisting the patient with meal selection based on their dietary requirements, and electronically entering the patient's meal order onto a mobile computing device at the patient bedside. In the room service models, patients place their meal orders by calling a dedicated number where staff take the meal orders and enter them directly into a computer, while the self-service model involves patients' entering their orders directly via bedside terminals. Prior to transitioning to an electronic meal ordering system, most hospitals had a traditional "printed menu" model.

Most of the literature discussing electronic meal ordering provided information on some level of evaluation of the impact of system implementation. Patient satisfaction outcomes were most frequently reported. Only a few studies examined the effectiveness of electronic meal ordering systems in reducing meal errors or the impact on patient nutritional intake. Cost savings, rates of food waste, and impact of the meal ordering process on staff were also evaluated in the literature, but the extent and quality of evidence on these indicators was limited. Overall, the available evidence indicated that electronic meal ordering systems may improve patient satisfaction, increase nutritional intake and decrease food waste.

Hospital food service reforms are complex, involving adjustments to the menu, ordering process, production, meal delivery and staffing. Future evaluations of electronic meal ordering should address the

organisational goals for implementation of a system-supported food service model, with methods for measuring defined indicators using robust measurement tools. Considerations and challenges for future evaluation studies are presented in this report.

3 Background

Malnutrition in hospital patients is a serious clinical issue associated with prolonged hospital stay, frequent readmissions, increased hospital infection, morbidity and mortality.[1-3] It is therefore important for hospitals to implement interventions that will support the provision of optimal nutritional management and care for patients. Health information technologies, such as electronic medical records, computerised provider order entry systems, laboratory information systems and medication management systems, have played an integral role in improving healthcare delivery, patient safety and clinical decision-making.[4] Nutrition information systems, such as dietary management systems, offer a valuable opportunity to enhance the efficiency of food services and support nutritional care.[5] Beyond supporting functions such as inventory and menu management, dietary management systems hold the potential for managing, delivering, and monitoring food, nutrient, and fluid intake on an individual patient basis and better identifying patients at-risk of malnutrition.[5, 6]

A variety of clinical and behavioural factors may influence dietary intake.[2, 3] Poor nutritional consumption may also be influenced by food service systems characterised by a poorly designed menu, inappropriate food preparation methods and complex ordering processes.[7] A review of food service systems where patients select meals closer to the time of consumption, such as the bulk trolley system, found that a more personalised meal service system can lead to improved patient satisfaction and energy intake.[8] However, a comparative analysis of plated versus bulk trolley systems found bulk systems to result in higher food waste with no beneficial effect on patient nutrition compared to plated systems.[9] Food service systems that incorporate electronic meal ordering offer an alternative to traditional models of patient meal service systems and combine a personalised meal service experience with the potential nutritional management benefits of dietary management systems.

In 2014, HealthShare NSW commenced the development of a new delivery model for patient food services. A set of nutrition standards for menus and specifications for therapeutic diets was developed by the Agency for Clinical Innovation (ACI) to facilitate centralised menu planning and food production.[10-12] These standards form part of a broader framework to improve nutritional care in NSW hospitals[13], including reform to the current paper-based meal ordering system with implementation of electronic meal ordering. Notional modelling by Deloitte[14, 15]of the impact associated with implementation of an electronic meal ordering system has suggested: process saving costs (i.e. by reducing the need to print, distribute, collect and process paper-based menus); reduced food wastage; reduced patient length of stay; and increased patient satisfaction through greater choice and more timely meal ordering and food delivery. However, it is currently unknown whether the anecdotally reported benefits of electronic meal ordering systems have been evaluated within the literature.

This report aims to identify and present a review of the existing evidence, from Australia and internationally, on electronic meal ordering system reforms and their associated impacts on hospital and patient outcomes. The main objectives of this report are to:

- Describe the types of electronic meal ordering systems and food service reforms related to the introduction of electronic meal ordering systems that have been reported in the literature
- Describe any nutritional screening and risk assessment protocols implemented alongside electronic meal ordering systems

- Present evidence of the impact of electronic meal ordering systems on patient outcomes and on the implications for staff, and
- Discuss considerations for future evaluations of electronic meal ordering systems based on the evidence identified in the literature.

4 Method

We sought to identify literature on reforms to meal ordering systems in healthcare facilities in developed countries where there has been an introduction of an electronic meal ordering system. The search focused on English-language literature published since the year 2000. We included peer-reviewed literature, as well as research reported in grey literature (e.g. reports by government departments and public or private health service providers).

4.1. Search methods

We undertook an initial general search for "electronic meal ordering" in the Google search engine. Titles and the short descriptive text underneath were screened for the first 10 pages of results (representing 100 individual results). Potentially relevant records were opened and reviewed. Relevant articles and documents were retrieved, while related sources were electronically bookmarked for subsequent follow-up. To supplement the Google search, searches within the top 10 journals in the nutrition and dietetics category, as ranked by the Web of Science citation index, were also conducted.

Keywords and their synonymous variations that appeared across the relevant results retrieved from the initial Google search were identified and noted. Complete reference details of scholarly articles identified from the Google search were also retrieved for identification of the specialised indexing terms (e.g. MeSH, Emtree terms) under which they were classified. An initial database search strategy was then formed using a combination of indexing terms and keywords. Indexing terms varied across databases, thus terms were mapped to their equivalents for use in the different databases. Search strategies were trialled and continually modified until relevant results from the initial hand-searching were also identified by the formal search strategy. The final search strategy used in Medline and Embase is presented in Table 1. The search strategies used for the remaining databases (CINAHL, Evidence-Based Medicine (EBM) Reviews, ProQuest, ScienceDirect, Web of Science, Scopus, Global Health, Joanna Briggs Institute of Evidence Based Practice, and Food Science and Technology Abstracts) are presented in Appendix A.

Reference lists of all literature identified as potentially relevant were reviewed. Article authors and individuals in hospitals where electronic meal ordering systems had been implemented were emailed a request for further available details and/or evidence from internal trials. A breakdown of the number of authors contacted and responses received is presented in Table 2. The complete list of sources that were hand-searched for additional peer-reviewed literature, as well as grey literature is summarised in Table 3.

Table 1. Literature search strategy applied in Medline and Embase

	Medline and Embase Search Strategy
1	exp Meals/
2	meal#.ab,ti.
3	food.ab.ti.
4	1 or 2 or 3
5	Food Preferences/ or Food Service, Hospital/ or Food Services/ or Food Handling/
6	Dietary Services/

7	Nutrition Assessment/
8	Dietetics/
9	Menu Planning/
10	food delivery.ab.ti.
11	food service#.ab,ti.
12	foodservice.ab,ti.
13	5 or 6 or 7 or 8 or 9 or 10 or 11 or 12
14	Information Systems/ or Health Information Systems/ or Hospital Information Systems/
15	information system#.ab,ti.
16	computer#.ab.ti.
17	order#.ab,ti.
18	ordering.ab,ti.
19	spoken.ab,ti.
20	electronic.ab,ti.
21	14 or 15 or 16 or 17 or 18 or 19 or 20
22	4 and 13 and 21
23	limit 22 to English language and publication year 2000n to current

/ denotes an indexed term

.ab.ti. = abstract and title

Table 2. Breakdown of authors and content experts contacted

Category of Expert	Number Contacted	Countries	Number Responded
Hospital Staff*	18	UK/US/Canada/Singapore/Australia	6
Academic	8	UK/Australia/Canada	6
Organisation	5	US/Australia/Singapore	1

*includes staff from foodservices, nutrition and dietetics, or information technology department

Table 3. List of sources hand-searched for peer-reviewed and grey literature

Grey Literature/Hand-searching
Google and Google Scholar
National Health Service (NHS) United Kingdom
Agency for Clinical Innovation (ACI)
ProQuest Dissertations and Theses Database
Top 10 Nutrition and Dietetics journals as ranked by Web of Science citation index

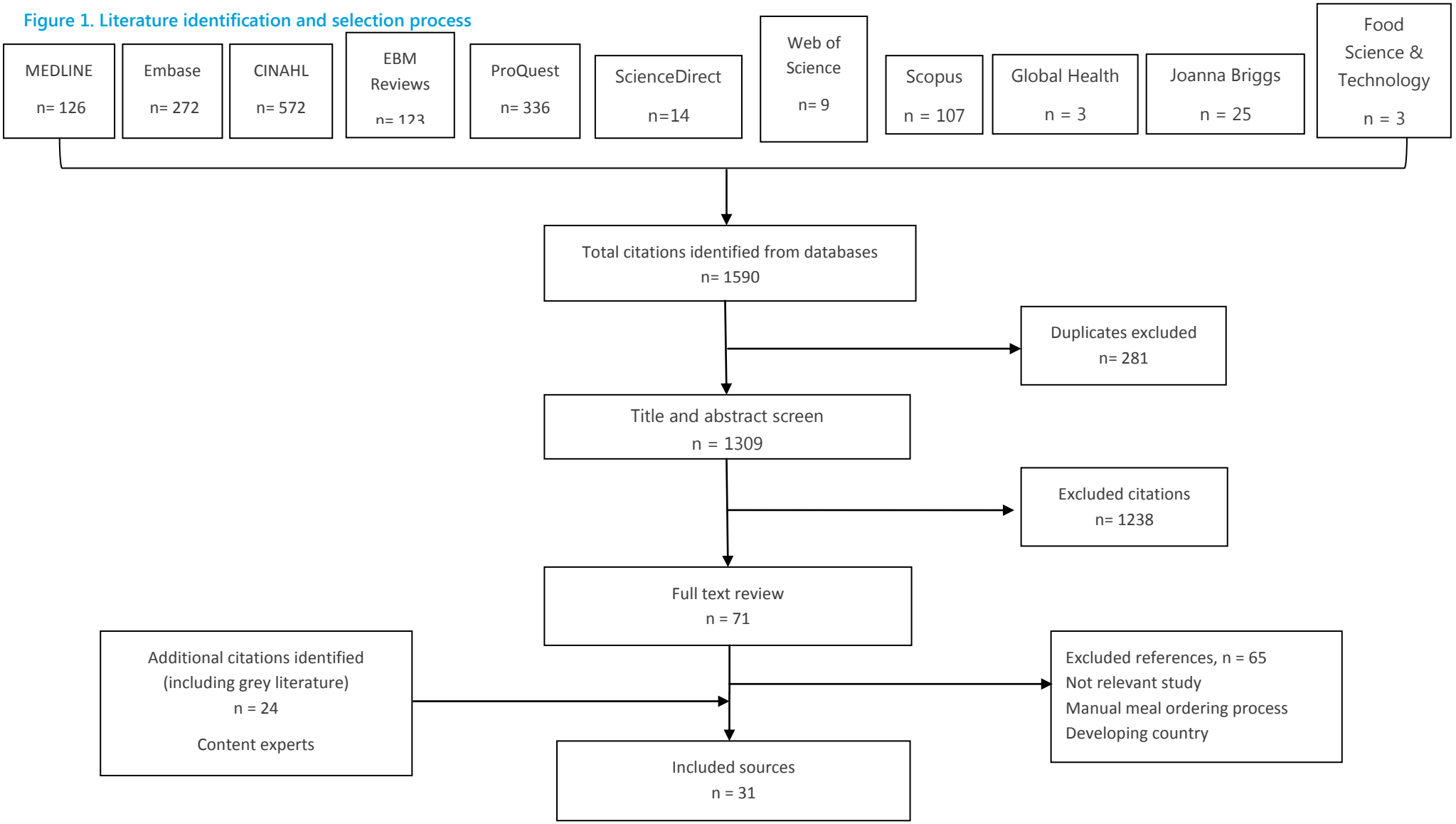
Canadian Foundation of Dietetic Research website and conference proceedings
South West Pacific Nutrition and Dietetic Conference proceedings
Proceedings of the Nutrition Society of Australia
Article reference lists
Authors/content experts – emailed request for information

4.2. Study Selection

Both the titles and abstracts of all unique citations from the database search were reviewed for relevance. Where an abstract was not available, the full-text of the article was retrieved for review. For the purposes of this review, electronic meal ordering was defined as any meal ordering process where patient food orders are entered directly into a computer (by either a staff member or the patient) and transmitted electronically to the kitchen.

All study types and sources reporting non-testimonial evidence relating to outcomes or descriptions of electronic meal ordering system implementations from both the database search and hand-searching were included in the review. Sources were excluded if they were: unrelated to the topic; featured electronic meal ordering outside the health context (e.g. restaurants, private residences); were set in developing countries; or had non-electronic food service models. While the search was not confined to hospital settings, we did not identify any literature that discussed electronic meal ordering systems in non-hospital health care settings. Ambiguous references were independently examined by two researchers and disagreements were resolved through discussion. The study selection process is diagrammatically represented in Figure 1.

Figure 1. Literature identification and selection process



5 Overview of the Literature

Literature describing electronic meal ordering systems and associated food service reforms was not extensive. In total, we identified 31 relevant sources of information comprising peer-reviewed publications, conference abstracts/posters, hospital newsletters and content expert presentations. Some individual sources pertained to the same hospitals and electronic meal ordering systems. In such cases, we pooled the multiple sources of information about the system to build a more complete picture regarding the system. Thus, overall the sources discussed electronic meal ordering in 22 hospitals.

5.1. Description of Electronic Meal Ordering Systems and Reforms

5.1.1. Types of Electonic Meal Ordering Systems and Reforms Reported in the Literature

Within the evidence base we identified three categories of food service models that incorporate electronic meal ordering systems: (i) the "spoken menu" model; (ii) the "room service" model; and (iii) the "self-service" model. Prior to transitioning to an electronic meal ordering system, most hospitals had a traditional "printed menu" model: where staff delivered printed paper meal ordering forms to patients' rooms, patients completed the forms to indicate their meal preferences and staff returned to collect the forms at a later point in time. Under the printed menu system, patients have limited interaction with meal ordering staff[16] and commonly do not receive their selected meals until their third day of stay in hospital.[17, 18] Additionally, orders are associated with the bed rather than the patient, thus if a patient is transferred or discharged, the newcomer to that bed receives the meal ordered by the previous patient.[19] In one study, however, prior to electronic meal ordering system implementation staff took patients' orders at the bedside but documented the orders on paper.[20] In another study, patients' meals were selected for them by a software system based on the patients' diet orders and food allergies.[21]

Spoken Menu

Of the three models, we identified the greatest number of sources describing spoken menu models. The spoken menu model involves a staff member attending the patient bedside, discussing food options with the patient, assisting them with meal selection based on their dietary requirements and taking the patient's meal order. The order can be documented on paper or entered onto a mobile device (e.g. personal digital assistant/smartphone, tablet computer or computer on wheels). For the purposes of this review, we only included literature that explicitly specified the use of mobile devices for meal ordering. Studies on spoken menu models that used paper, or were ambiguous about the means by which orders were taken[22-24], were excluded from this review.[17, 20, 21, 25-30] The reasons reported for changing to a spoken menu system included: to provide support to patients at meal times[25]; allow patients to choose meals closer to meal times[17, 20, 21]; improve order appropriateness[20] and accuracy[20]; increase food consumption[25]; improve nutrition[25]; reduce food cost[21] and waste[21, 28]; improve efficiency[28]; and improve patient[21, 31] and staff satisfaction with food services.[31] However, there is only limited evidence evaluating whether these benefits are actually attained following spoken menu implementation (see Section 3.2).

A summary of the spoken menu systems reported in the literature is presented in Box 1. There were differences in how the spoken menu system operated in the different hospitals with regards to when and how frequently meal orders are taken. In some hospitals, meal orders are taken the day prior to meal delivery[25, 32], while in other hospitals orders are taken as close to the next meal time as possible (e.g. within two hours of meal delivery).[17, 20, 21, 25, 33, 34] Across most studies, responsibility for taking meal orders was

largely assigned to the food services staff (e.g. catering associates, catering staff, customer service associates).[21, 25, 31] However, in two studies conducted in Australian hospitals[27, 30] and one study in a Canadian hospital[17], staff from nutrition and dietetics (trained nutrition or dietary assistants) were responsible for taking meal orders.

Box 1. Summary of spoken menu reforms reported in the literature

Prince Charles Hospital, Queensland, Australia[28, 29] – CBORD implemented in 2006. Orders are taken at the bedside by food service staff. Automatic generation of meal order tickets.

North York General Hospital (NYGH) and Humber River Regional Hospital (HRRH), Toronto, Canada[25] – Steamplicity food service system implemented in 2009. Reform included changes to the menu, ordering procedures and cooking process. Orders are taken at the bedside by catering associates several times a day.

Hollywood Private Hospital, Perth, Western Australia[26, 31, 32] – Chefmax implemented in 2011. Multi-faceted program of change to transform the entire meal production, ordering and delivery process. Included new menus reviewed by dietetics, electronic meal ordering, kitchen process improvement and staff training. Orders are taken by catering staff for meals that will be delivered the following day.

Sturgeon Community Hospital, Alberta, Canada[33] – trialled spoken menu in 2004. Orders were taken twice daily, with food service staff taking orders as close to the next meal time as possible.

Wollongong Hospital, Port Kembla Hospital, Shellharbour Hospital, Bulli Hospital and Shoalhaven Hospital, New South Wales, Australia[30] – implemented CBORD. The hospitals moved to a centralised cook-chill production alongside implementation of electronic meal ordering. Orders are taken by nutrition assistants and uploaded into CBORD.

Trillium Health Centre, Toronto, Canada[21, 34, 35] – under the old system, patients' meals were selected for them by a software system based on the patients' diet orders and food allergies. Implemented Meditech food service software. Only reform was to meal ordering process (no changes to menu, method of preparation, or delivery). Lunch and dinner orders are taken by a customer service associate (food services staff member) once a day.

St Michael's Hospital, Toronto, Canada[17] – implemented CBORD. Orders taken by dietary assistants on a daily basis and wirelessly uploaded into the CBORD food management system.

St Vincent's Private Hospital, Sydney, Australia[27, 36-38] – under the old system, nutrition assistants delivered and collected printed paper menus and then entered the orders onto the computer. Implemented CBORD. The menu and food items offered did not change. Orders are taken by nutrition assistants for dinner the same day, and breakfast and lunch for the following day.

KK Women's and Children's Hospital, Singapore[20] – under the old system, staff took patients' orders at the bedside but the orders were documented on paper. Only change was implementation of electronic meal ordering with orders taken by food service assistant.

Casey Hospital, Victoria, Australia[39] – implemented a computerised menu management system, incorporating purchasing and inventory control, therapeutic diet coding and electronic meal ordering. Orders taken by food service staff.

Room Service

The room service system is modelled on the room service concept commonly used in hotels, where food is ordered and delivered shortly after. To place meal orders, patients call a dedicated number where staff take the orders and enter them directly onto a computer. The identified literature discussed the introduction of room service in two Canadian hospitals[18, 40], one US hospital[41], one in The Netherlands[42] and one Australian hospital.[16] The reasons reported for changing to a room service system included: to reduce food waste [16, 41]; reduce late tray deliveries[16, 18]; meet the nutritional needs of patients[16, 42]; create efficiencies[16]; increase patient satisfaction[40, 42]; change the way dietetic staff perform their work[41]; give patients greater control by allowing them to choose when they wish to eat[18, 41]; improve food quality[18]; and reduce meal ordering lead times[18]. However, there is only limited evaluation of these anticipated benefits or evidence demonstrating that these benefits are attained following room service implementation (see Section 3.2).

A summary of the spoken menu systems reported in the literature is presented in Box 2. There were differences in how the room service system operated in the different hospitals with regards to when meal orders could be placed. In some hospitals, meals could be ordered at any time throughout the day[16, 42], while in other hospitals orders could only be placed during two-hour periods at breakfast, lunch and dinner while the dedicated phone lines were open.[18]

Box 2. Summary of Room Service Reforms Reported in the Literature

Mater Private Hospital, Queensland, Australia[16, 43-45] – old system was a 14-day cycle, cook-fresh and chill production, with paper menus delivered in the morning for selection of breakfast, lunch and dinner. Meal times were set at 6am, 12noon and 5:30pm. Reforms implemented in 2013 and included redesign of menu, food production, food delivery and workflow changes. Meal service is available between 6:30am to 7:00pm. Room service representatives take patients' calls. Meals are delivered within 45 minutes. Some patients, for which room service was considered inappropriate, had a room service representative visit them to take their order at the bedside using a tablet computer.

Children's Hospital of Eastern Ontario, Ottawa, Canada[40] – old system required patients to order their meals two days in advance. With room service, patients call and their orders are entered into CBORD. Meals are delivered to patients within 20 minutes.

Northeast Health Systems, Massachusetts, United States[41] – old system required patients to order their meals via paper menus 24 hours in advance. Implemented a service called "At Your Request". Nutrition associates take patients' calls and enters order onto a computer. The meal order ticket is automatically sent to the kitchen. Meals are delivered within 45 minutes of ordering.

The Hospital for Sick Children, Toronto, Canada[18, 46-48] – old system was a cold-plating rethermalization process, with patients required to select their meals two days in advance and meals delivered at set times throughout the day. Reforms implemented over a one-year period (2005-2006) and included kitchen renovation, redesign of menus, new meal order and delivery system and staffing changes. Implemented service called "MealTrain" supported by Computrition. Meal orders can be placed during two-hour periods at breakfast, lunch and dinner when phone lines are open. Food service staff enter the orders onto a computer. The meal order ticket is automatically sent to the kitchen. Meals are delivered within 45 minutes of ordering.

Hospital Gelderse Vallei, Ede, The Netherlands[42] – old system was a cold-plating rethermalization process, with patients required to order their meals a day in advance. Meals times were set at 7:15am, 12:15pm, and 5:15pm. Implemented service called "At Your Request" supported by Sodexo. Meal service is available between 7:00am to 7:00pm. Trained operators in the nutrition call centre take patients' calls and enter the order in the menu management system. Meals are delivered within 45 minutes.

Self-Service

The self-service model involves patients' entering their orders directly via bedside terminals. We only identified two studies discussing the introduction of self-service, both of which were conducted in the UK (Box 3). The reasons reported for changing to a self-service model included: improving food service[19]; improving patient satisfaction[19]; providing patients with a greater level of choice[19]; reduced food waste[49]; and improved patient nutrition.[49] However, we only identified limited evidence assessing whether these benefits are attained following implementation (see Section 3.2).

Box 3. Summary of self-service reforms reported in the literature

Undisclosed Hospital, United Kingdom[19] – old system was paper menus where orders were placed 24 hours in advance. Patients completed the forms, ward staff collected the forms and consolidated the orders and then called the kitchen to place the orders for the following day. In the new system, patients access an electronic menu and make their meal order selections using their bedside TV screen. Orders are transmitted directly to the catering department. The electronic menu contains pictures and a comprehensive description of each meal as well as details about the ingredients and their origin, nutrition and allergen information. Meals are delivered within hours of an order.

Royal Bournemouth Hospital, Bournemouth, United Kingdom[49] – old system was paper menus where orders were placed 24 hours in advance. Patients completed the forms, ward staff collected the forms and scanned or entered the data onto a computer. A new system, Hospedia, was introduced where patients could access an electronic menu and make their meal order selections using their bedside TV screen. The electronic menu contains pictures and a description of each meal as well as nutrition information. Meals are delivered within two hours of an order.

5.1.2. Nutritional Screening and Risk Assessment Protocols in Electronic Meal Ordering

The identified evidence base of electronic meal ordering system reforms provided only minimal information regarding nutritional screening or risk assessment protocols. Only one study relating to a Private Hospital in Sydney, Australia, provided detailed discussion of nutritional screening and risk assessment protocols.[36] At the St Vincent's Private Hospital nursing staff were responsible for completing the nutritional risk assessment in the electronic medical record system within 24 hours of patient admission. Nurses then update the nutritional assessment on a weekly basis, or following a change in patient health status. The assessment form calculates a score, which if greater than or equal to two indicates nutritional risk and refers the patient to a dietician. Dieticians record relevant dietary restrictions for the patient, which can be used to inform patients' diet orders, so that patients are presented with options that are more suitable for them and their nutritional needs.

In spoken menu systems, a common feature was that the menu options presented on the mobile computing devices were personalised to patients' specific diet orders so that the staff member taking the order only provided patients with choices within the scope of their diet orders.[25, 26, 28, 30, 33] Similarly, in room service systems diet orders are displayed when food staff take patients' meal requests, allowing them to ensure the requests are appropriate, and if not, assist the patient in making an alternative choice.[16, 18, 40-42] In self-service models, only menu options suitable for the patients' specific dietary requirements are presented to the patient, so that patients cannot order a meal that could cause them further medical issues.[49] Several spoken menu and room service systems also included allergy information.[18, 26, 28, 30, 32] One study reported that the integration of the electronic meal ordering system with a nutritional analysis module allowed

monitoring of food ordered by patients.[28] The nutritional analysis could then be used to assess whether patients (e.g. diabetic patients) are ordering appropriate meals or if dietary education is required.

In the current evidence base, there are no descriptions of functioning mechanisms implemented to assess food consumption or nutrition outcomes. One UK study describes a prototype spoken menu system (Hopsitalfoodie), however contact with the study author confirmed that the system has not progressed beyond the development stage.[6] The system is designed to be a total food and nutrition management system, intended to facilitate the provision of adequate food and nutrition to patients. The nutrition management system is operated through touchscreens at the patient bedside or on mobile computers and includes a 'wipe away' food monitoring application allowing staff to capture food consumption by wiping away the portion of the food consumed by the patient. This nutrition management system is linked to a nutrition composition database to allow nutrition intake to be recorded, achievement of nutrition targets to be monitored and provide shortfall alerts. However, the system has not been implemented nor tested within any facilities to date. In a report on the Mater Private Hospital system, McCray[16] indicates that the hospital intends to implement a module to their meal ordering system, which allows monitoring of nutritional intake and plate waste. However, no further information on the module was provided.

5.2. Evaluation of Electronic Meal Ordering Systems

5.2.1. Nature and Quality of the Evidence

Most of the literature discussing the electronic meal ordering models (spoken menu, room service and self-service) provided some level of evaluation of the impact of system implementation. The outcome predominantly assessed related to patient satisfaction. However, a small number of studies also examined the impact of electronic meal ordering on nutritional outcomes, staff, and food and cost outcomes. We used the Effective Public Health Practice Project (EPHPP)[50] quality assessment tool to rate the methodological quality of the evaluation studies. Using the EPHPP tool, studies are attributed a rating of strong, moderate, or weak based on six components: (a) selection bias; (b) study design; (c) confounders; (d) blinding; (e) data collection methods; and (f) withdrawal and drop-outs. Only five studies were rated as providing a moderate quality of evidence, with the remainder rated as weak. No studies were rated as having a strong methodology or level of evidence.

5.2.2. Impact of Electronic Meal Ordering Systems

The included studies evaluated a range of hospital and patient outcomes, including patient satisfaction, nutritional outcomes (nutrition intake, malnutrition risk scores), clinical outcomes (hospital length of stay, body weight, handgrip strength, hospital incident reports), food and cost outcomes (food waste, food cost savings, meal accuracy, late trays, process cost savings) and impacts on staff (satisfaction, distribution of time, role changes, creation of new roles).

Patient Satisfaction

Several of the identified studies reported increased patient satisfaction following the implementation of electronic meal ordering systems. However, only a small number of studies actually assessed or quantified this increase. Assessment of patient satisfaction in the studies was largely conducted through the use of surveys.

Dillon et al.[25] reported increased patient satisfaction at two Canadian hospitals which implemented spoken menu models. Prior to implementation, the patient satisfaction score for the service provided at the Humber River Regional Hospital was 95% and 88% at the North York General Hospital. Patient satisfaction with food service provision increased in both sites in the year following spoken menu implementation (99%

and 98%, respectively). Patient satisfaction scores also increased regarding the degree to which food preferences were respected (from 89% to 94% and 77% to 86%, respectively).

At the St Michael's Hospital in Canada[17], patients' overall satisfaction with food services was higher under the spoken menu model (71%) than the printed menu model (64%). Although the various aspects of food quality and service received higher satisfaction scores in the spoken menu model (ranging between 1.7% and 10.8% higher than the printed menu model), no statistically significant changes were found in satisfaction with: menu variety; food presentation, temperature, or taste; friendliness of food service staff; or overall food quality ($p>0.05$).

Implementation of the spoken menu model at the Trillium Health Centre in Canada was also viewed favourably by patients, with 87% recommending that the hospital continue to have food service representatives visit them daily to take their meal orders.[21, 34, 35] Although there were no changes to the menu or preparation of food, patient satisfaction increased between 10% and 30% for the various aspects of food quality, including: variety of food; availability of familiar food; taste and presentation; and overall food quality.[34]

At St Vincent's Private Hospital in Australia, 84% of patients rated the food service as 'very good' or 'good' under the printed menu model.[27] Levels of satisfaction did not change significantly under the spoken menu model, with 82% of patients rating the food service as 'very good' or 'good' ($p>0.05$). The spoken menu cohort were asked about their meal ordering preferences. The majority (80%) of patients preferred the spoken menu model, 14% preferred the printed menu model and 6% did not have a preference. Patients at the Prince Charles Hospital, Australia, were also asked about their meal ordering preferences. Most patients (54%) indicated a preference for the spoken menu model, while 26% preferred the printed menu model, and 20% did not have a preference.[29]

Studies assessing room service models in two children's hospitals in Canada and one in the Netherlands also reported increased patient satisfaction. Kuperberg et al.[46] indicated that satisfaction with food temperature, meal serving times and perceptions that the food met patient needs, all increased significantly under the room service model ($p<0.05$, however, no patient satisfaction scores were provided). The study reported that 93% of patients were satisfied with food being delivered promptly and 97% were satisfied with the staff who took the meal orders. Wadden et al.[40] similarly reported that patient ratings of 'greatly exceeding' or 'exceeding expectations' for overall satisfaction with meals, food quality, temperature and variety of foods all increased significantly under the room service model ($p<0.001$, however, no patient satisfaction scores were provided). Doorduijn et al.[42] reported that, on a scale of 1-10, patient satisfaction with meal service provision significantly increased from 7.5 to 8.1 ($p=0.008$). Patients rated food choice, food supply, presentation, autonomy (freedom to order food) more favourably in the room service model, but there was no change in the rating of food quality.

As indicated by Maunder[27], satisfaction with and preference for electronic meal ordering is likely a result of patients feeling informed and involved in their meal ordering decisions, being able to ask questions, and have concerns resolved immediately by the staff member taking their order. However, these metrics were not assessed as part of patient satisfaction scores in the identified evidence base. Rather, the patient satisfaction scores largely relate to food quality metrics, such as temperature, taste and variety, which are more likely to be influenced by changes to food preparation and delivery systems, such as those that occurred in room service model reforms[40, 46], than the means by which meals are ordered.

Nutritional Outcomes

There was very limited evidence regarding the impact of electronic meal ordering systems on nutritional outcomes. Two studies reported an increase in food consumption following implementation of the spoken menu model[33, 34] and one study of the room service model reported a significant increase in protein and energy intake.[45] However, none of these studies provided figures to demonstrate assessment of these nutritional outcomes before and after electronic meal ordering reforms. We only identified three studies that reported on the evaluation of electronic meal ordering reforms on nutritional outcomes: one that assessed a spoken menu model in an Australian hospital[27] and two that examined room service models[42, 46] The nutritional outcomes that were measured in these studies included: food consumption; energy intake; protein intake; carbohydrate intake; fat intake; energy requirement achieved; protein requirement achieved; body weight; malnutrition score; and number of meal items ordered. Two studies reported positive implications[27, 46] and one reported no change[42] following meal ordering changes.

Maunder[27] used observational recordings and photographs of meal trays (before and after patient intake) to evaluate dietary intake. Consumption was recorded as 0%, 25%, 50%, 75% or 100% of food served to the patient. The percentage of items consumed was entered into a database containing nutritional information in order to calculate energy and protein intake. Consumption was found to be higher in the spoken menu cohort, with 98% of patients consuming at least 50% of their main meal compared with 76% of patients in the printed menu cohort ($p<0.05$). The increased consumption translated into increased mean daily energy intake for the spoken menu patients (8,273 kilojoules compared to 6,273 kilojoules for printed menu patients; $p<0.05$), as well as increased protein intake (83g compared to 66g; $p<0.05$). The increased consumption also meant that more than half of spoken menu patients achieved their estimated dietary goals (57% for energy and 50% for protein), compared to approximately 30% of printed menu patients (31% for energy and 28% for protein). The study also reported that spoken menu patients selected a significantly greater number of menu item choices than the printed menu cohort for their lunch and dinner meal orders ($p<0.05$).

Kuperberg[46] used a similar approach to that used by Maunder et al. in order to assess dietary intake for paediatric patients in a room service model. When plates were collected, the percentage of food items remaining on the plate were compared to the order and recorded as 0%, 25%, 50%, 75% or 100%. The inverse percentage of food items remaining represented consumption. The energy and macronutrient intake of food consumed was calculated using Diet Analysis Plus software. A significant increase in energy, protein, carbohydrate and fat intake was identified at lunch ($p<0.05$), with energy intake increasing by 45%, carbohydrates by 36%, protein by 39%, and fat by 48% (actual intake numbers pre-and post-implementation of the room service model were not provided). A corresponding study[48] evaluated the food choices ordered by paediatric patients using the room services model, and how these choices compared to Canadian intake guidelines. Food orders were found to meet the minimum requirement of five servings of fruit and vegetables per day and was higher than the 4.5 servings a day consumed by the general Canadian population. However, whether children consumed the entirety of their order was not assessed. Additionally, excessive ordering of foods considered to be energy-dense and of low nutritional value was seen.

Doorduijn et al.[42] examined energy and protein intake in a small sub-group of patients receiving energy- and protein-enriched menus. There was no significant difference between the printed menu group and the room service group with respect to energy intake (1,461 calories compared to 1,378 calories, respectively)($p>0.05$). However, the printed menu group had a significantly higher protein intake than the room service group (0.91 versus 0.84 grams per kilogram of body weight, respectively)($p<0.05$). Malnutrition scores were also examined for the two study groups. On admission a greater number of patients were identified as being at risk of malnourishment in the room service group (47 patients

compared to 37 patients in the printed menu group). By the day before discharge, 7 patients in the room service group and 8 in the printed menu group had improved scores and were no longer considered at risk. The authors found no significant differences between the printed menu and room services groups in change in patient body weight during the hospital stay, which decreased by an average of 0.2 kilograms for both groups (p=0.851).

Clinical Outcomes

There was no tangible evidence of the impact of electronic meal ordering systems on clinical outcomes. A study of a spoken menu model at the Prince Charles Hospital in Queensland, Australia, alluded to improvements in patient safety stating that no clinical incidents had been observed following the implementation of electronic meal ordering with an allergy management module.[28] However, no additional information was provided. A study by Maunder et al.[27], provided a comparison between the participant demographics of the two cohorts in the study (i.e. the printed menu cohort and the spoken menu cohort). The average length of stay for the spoken menu cohort was 8.5 days (SD 11.9), which was significantly shorter than the printed menu cohort who had an average length of stay of 9.8 days (SD 9.7; p=0.010). However, this is likely because there were also significant differences in the medical classifications (types of surgeries) of the cohorts. Similarly, Doorduijn et al.[42] reported a significant difference in the length of stay between the printed menu cohort and the room service cohort (8.9 days versus 7.3 days, respectively; p=0.038). However, there were also significant differences in the proportion of surgical patients in the two study cohorts, with significantly fewer surgical patients in the room service group (26% versus 42%, respectively). Additionally, neither study was sufficiently powered to test whether there was an association between the intervention and length of stay. Doorduijn et al.[42] also assessed handgrip strength between the two study groups and found no change in handgrip strength between the two groups (30.2 kilograms on admission for both groups, and 30.5 kilograms for the printed menu group and 30.6 kilograms for the room service group on discharge).

Impact on Staff

Across most studies, responsibility for taking meal orders was assigned to the food services staff (e.g. catering associates, catering staff, customer service associates). However, in two spoken menu studies conducted in Australian hospitals and one study in a Canadian hospital, staff from nutrition and dietetics (trained nutrition or dietary assistants) were responsible for taking meal orders. Studies highlighted the need for these staff to be skilled or to undergo training, such as training in patient interaction, the necessary information technology skills for taking patient orders and confirming compliance with diet orders.[25] In spoken menu models, staff taking patient orders were expected to assist patients with making suitable meal choices, ensure compliance with diet orders, provide nutritional education and handle food related concerns.[17, 25, 27, 30, 36] Similarly, in room service models, food service staff interact with patients via telephone and are expected to respond to patients' requests and needs, while ensuring meal requests are compliant with diet orders.[18, 40-43]

Across spoken menu models, changes to existing staff tasks and workflow were common. Maunder et al.[27] reported that in the printed menu model, qualified nutrition assistants were responsible for delivering and collecting the printed paper menus from the wards and then entering the menu orders once they returned to their office. With the introduction of spoken menu, the nutrition assistants visited patients, discussed their meal orders, assisted with suitable meal choices, answered patients' questions and entered orders electronically at the bedside. Through time recordings of patient interactions, it was found that the average time nutrition assistants spent with patients increased significantly from 0.33 to 3.5 minutes per patient per day (p<0.05). Elliot et al.[17] similarly reported an increase in patient interaction time following the

implementation of a spoken menu. The labour intensive nature of the spoken menu model required the dietary assistants to be replaced by dietetic interns. The average time dietetic interns spent with each patient under the spoken menu model was 7.7 minutes.

Maunder et al.[27] undertook interviews with nutrition assistants who reported an increase in job satisfaction, primarily due to the shift from office-based duties to using their nutrition knowledge to assist patients in their meal selections. Foreman[33] and Dillon[25] likewise indicated that staff responsible for taking meal orders felt an increase in job satisfaction. A survey of nursing staff conducted at St Vincent's Private Hospital reported that nurses viewed the increased presence of nutrition assistants on the wards favourably, and felt that the nutrition assistants provided nutritional advice and education to patients, and dealt with meal issues in a prompt manner.[37]

There was no evidence within the identified literature to indicate whether different staff roles or skill levels had an effect on patient outcomes in electronic meal ordering systems.

Food and Cost Outcomes

An attribute of most electronic meal ordering systems is that patients are able to order what they want to eat closer to meal times than with printed menu systems, which is anticipated to reduce food waste and decrease cost.[18, 41] However, the evidence base assessing these anticipated benefits is limited.

The reduction of food waste is not only achieved through increased food consumption, but through reduced errors and reduced duplicate/spare trays. Patch et al.[30] examined plating errors following the implementation of a spoken menu system at five hospitals throughout New South Wales, Australia. Errors were identified by comparing the meal provided to the patient with the ticket printed on the meal tray. Errors in meal provision were not collected prior to the spoken menu system. On average, across the five hospitals, the error rate was 15% at four months after spoken menu implementation. This reduced to an error rate of 9% after the system had been in place for one year. In room service models, two studies reported a reduction in food waste: one at the Mater Private Hospital, Queensland, which indicated a reduction from 29% in printed menu model to 12% in the room service model[16]; and the other at a paediatric hospital in Canada, which indicated that food waste was significantly reduced at breakfast, lunch, and dinner ($p<0.05$) as a result of less food being ordered (21% reduction) and fewer duplicate/excess trays being prepared (reduction of 23%).[46] Food waste was also found to decrease in a self-service model, from 7% for printed menus to 4% in self-service.[49]

With regards to cost, studies that assessed food waste suggested that this resulted in cost savings. Kuperberg et al.[46], for example, reported a cost reduction of 36% at breakfast, 29% at lunch and 19% at dinner following implementation of the room service model. Steele[34] also reported a food cost saving of CAD$0.07/patient day. Several studies noted that there were cost increases associated with food service reforms, particularly with the staff required to take patient orders both in spoken menu models[25, 34] and room service models.[46] However, there were no robust evaluations of cost among the identified evidence base.

6 Considerations for Further Research and Evaluation

6.1. Challenges in Existing Evaluations of Electronic Meal Ordering Systems

Emergent from the literature are three distinct system-supported alternatives to the traditional printed menu model of hospital patient meal ordering and delivery: the spoken menu, room service and self-service meal ordering. Electronic meal ordering system reforms have been evaluated through the measurement of both hospital and patient outcome indicators. Patient satisfaction outcomes were most frequently reported.[17, 21, 25, 27, 40, 42, 46] Only a few studies examined the effect of electronic meal ordering systems in reducing meal errors[30] and their impact on patient nutritional intake.[27, 42, 46] Cost savings, rates of food waste and impact of the meal ordering process on staff were also evaluated in the literature, but the extent and quality of evidence of these indicators is limited.

The issue of malnutrition in hospital patients and its relationship with adverse clinical outcomes is well documented in the literature.[1-3, 51] Despite the potential for food and nutritional management systems to improve patient meal satisfaction and increase intake, the impact of electronic meal ordering systems on nutritional outcomes have been scant. Methods for assessing nutritional intake have included visual estimation of consumption (based on food remaining on the tray) and calculation of the nutrient content of the food consumed[27, 46], recording of meals ordered and calculation of nutrient content from assumption of total meal consumption[42, 48], and weighing of individual portions of remaining food to determine the portion of the meal consumed.[7] While the weighed method produces the most accurate results, it is time and resource intensive and may present difficulties for completion with limited disruption or delay to normal food service operations.[7] Other confounding factors identified included patient consumption of foods brought in by visitors, or visitor consumption of the patient meal.[46] The fact that there are different approaches used for measuring the same outcome metric (food consumption) makes it difficult to make valid comparisons between studies. Another challenge was that often, there was limited information available on printed menu systems as paper-based ordering information was not kept.[42] Further, one study argued that the nature of a live hospital environment rendered more robust study designs, such as randomised controlled trials, not feasible.[27] A summary of the evaluation outcomes assessed in the existing literature and the challenges encountered are presented in Table 4.

Hospital meal delivery reforms are complex involving adjustments to the menu, ordering process, production, meal delivery and staffing. Future evaluations must address the organisational goals for implementation of a system-supported food service model, with methods for measuring defined indicators using robust measurement tools.

Table 4. Evaluation outcomes and indicators used in existing studies

Evaluation Outcomes	Indicators Measured	EPHPP Quality Rating	Comment on Challenges
Patient satisfaction	• Satisfaction with ordering process • Overall satisfaction with meal • Quality of food • Temperature of food • Flavour of food • Variety of meal options • Courtesy of serving staff • Ease of use of bedside ordering for self-service	Weak–Moderate	Increases in patient satisfaction following electronic meal ordering system implementation were commonly reported in the literature; however, methods for assessment of this metric were unclear in many sources. Positive changes in patient satisfaction scores relate largely to food quality, which are more likely associated with food preparation methods and delivery systems, than the means by which meals are ordered. Further research should focus on the various dimensions specific to the meal ordering component to achieve findings attributable to this intervention.
Nutritional outcomes	• Overall food consumption • Energy intake (protein, carbohydrates, fat) • Meeting recommended nutritional intake guidelines • Patient weight during hospital stay • Malnutrition risk scores	Weak–Moderate	Very limited evidence in this area. Assessment of patient nutritional outcomes through measurement of plate waste/consumption rates are time and labour intensive. Confounders to findings (such as potential patient consumption of externally sourced food brought in by visitors) are hard to control for in a live hospital environment.

Clinical outcomes	• Adverse events • Length of stay • Handgrip strength	Weak–Moderate	Unable to draw conclusions about the impact of electronic meal ordering on patient clinical outcomes due to the limited evidence-base. Studies have not been sufficiently powered to test whether there was an association between the intervention and length of stay.
Impact on staff	• Distribution of staff time • Staff workload • Staff satisfaction	Weak–Moderate	Electronic meal ordering system implementation represents a complete change in the process and model of inpatient food service delivery. Despite this, studies exploring staff implications are scant. Few studies examined staff impacts as a core outcome measure.
Food and cost outcomes	• Meal accuracy • Food waste • Total meals ordered, including duplicate and excess meals • Process costs (labour, food waste, printing paper menus)	Weak–Moderate	Studies measuring food waste and cost lack robustness and more sophisticated study designs are required to assess food cost savings (from decreased waste) against the costs of electronic meal ordering system implementation and the resources required to manage the ordering process.

6.2. Further Research Considerations

The strength of the evidence provided by an individual study depends on the ability of the study design to minimise the possibility of bias and to maximise attribution (i.e. the extent to which the introduction on the electronic meal ordering system can be attributed to the desired outcomes). The hierarchy of study types adopted by the Agency for Health Care Policy and Research is widely accepted as reliable in this regard and is given in Box 4.[52] Among the identified studies in this review, 12 used pre-post study designs.[16, 17, 19-21, 27, 31, 33, 36, 40, 46, 49] None employed a controlled or randomised design, which produce stronger evidence in relation to the effects of the system on the process and outcome indicators measured. Application of such study designs (e.g. a controlled before and after study) would produce more robust evidence regarding electronic meal ordering systems and their impact on patient clinical outcomes, cost and work flow of the staff in an objective and unbiased way. The following sub-sections provide considerations for future research.

Box 4. Hierarchy of study types by descending level of evidence

1. Systematic reviews and meta-analyses of randomised controlled trials
2. Randomised controlled trials
3. Non-randomised intervention studies
4. Observational studies
5. Non-experimental studies
6. Expert opinion

Audits, data linkage and data mining

Identifying relevant data from existing hospital records can be a valuable means to examine the effect of the new technology on a range of efficiency and effectiveness indicators. For instance, linking hospital datasets (patient administration, electronic medicinal records) can provide valuable and readily available information about the effect of the system on different components of the patient journey (e.g. length of patient stay, adverse events, co-morbidities, readmissions) that are related to the impact of the electronic meal ordering system.[53]

Observational time and motion studies

Time and motion studies allow the measurement of what clinicians and health professionals are doing, how long they take and where they are doing it. The Work Observation Method by Activity Timing (WOMBAT) technique has been developed to conduct these observational time and motion studies using software on a handheld computer.[54] Before and after assessment using WOMBAT can reveal changing in health professionals' distribution of time.

Economic Evaluations

Economic studies to support cost-utility and cost-effectiveness analyses can provide insights into the costs associated with interventions, as well as relating costs to the outcomes produced by the technology.[55]

Formative and summative evaluations

Research that investigates the influence of a technology on clinical work processes can be formative or summative in nature. Formative methods are geared toward the process and early outcome indicators as a result of system implementation. Summative evaluations are geared towards an assessment of the outcomes as a consequence of the technology. Formative methods are valuable for identifying key factors

that are being affected or what is changing. Summative methods are more geared to providing answers about the outcome.[56]

Qualitative research

Qualitative research can be described as a means of investigating experiences from the stand point of those being studied (e.g. patients, clinicians, allied health staff) which are sensitive to the context of the individual's situation.[57] While interviews and focus groups may examine how people make sense of a particular situation, observations of activities (i.e. ethnography) can help to understand the context and situation.[58] Qualitative research can help to answer the "why" question – why did the technology have a desired/undesired effect? Qualitative research can also help to identify what system implementation is expected to improve.

Targeting Groups

There is a need to identify who the intervention is most likely to impact (i.e. which clinical sub-groups, such as geriatric patients, are likely to see the greatest benefit from the implementation of an electronic meal ordering system). It is also important to obtain baseline measures of these groups (e.g. nutrition status in a printed menu system) to allow comparison following implementation of electronic ordering systems.

7 Conclusion

Between 2000 and 2015, there has only been limited evaluation of electronic meal ordering systems. The available evidence is largely weak to moderate at best, particularly regarding patient clinical outcomes. However, electronic meal ordering systems have been shown to improve patient satisfaction, increase nutritional intake and decrease food waste.

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9 Appendices

Appendix A: Database and grey literature search strategies

Database/Source	Search Strategy	
Global Health Food Science and Technology Abstracts	1	meal.ab,ti.
	2	order#.ab,ti.
	3	service.ab,ti.
	4	delivery.ab,ti.
	5	2 or 3 or 4
	6	electronic.ab,ti.
	7	computer.ab,ti.
	8	spoken.ab,ti.
	9	6 or 7 or 8
	10	1 and 5 and 9
	limit 10 to (English language and yr="2000-current")	
Evidence–Based Medicine (EBM) Reviews	1	meal.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw]
	2	meals.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw]
	3	food.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw]
	4	1 or 2 or 3
	5	food preferences.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw]

	6	food services.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw]
	7	food handling .mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw]
	8	dietary services.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw]
	9	nutrition assessment.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw]
	10	dietetics.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw]
	11	menu planning.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw]
	12	food delivery.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw]
	13	foodservice.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw]
	14	5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13
	15	information system.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw]
	16	computer.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw]
	17	order*.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw]
	18	spoken.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw]
	19	electronic.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw]
	20	15 or 16 or 17 or 18 or 19
	21	4 and 14 and 20
	22	limit 21 to English language [Limit not valid in CDSR,ACP Journal Club,DARE,CLCMR; records were retained]
	limit 22 to yr="2000-current"	
CINAHL	1	(MH "Meals+")
	2	meals
	3	food

	4	S1 OR S2 OR S3
	5	(MH "Food Preferences")
	6	(MH "Food Services")
	7	(MH "Food Service Department")
	8	(MH "Food Handling")
	9	(MH "Nutrition Services")
	10	(MH "Nutrition Assessment")
	11	(MH "Dietetics")
	12	(MH "Menu Planning")
	13	food delivery
	14	food services
	15	foodservice
	16	S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15
	17	(MH "Information Systems") OR (MH "Health Information Systems") OR (MH "Hospital Information Systems")
	18	information system
	19	computer
	20	order
	21	ordering
	22	spoken
	23	electronic
	24	S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23

	S4 AND S16 AND S24
Web of Science	1 (TI=(meal*)) AND **LANGUAGE:** (English) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, ESCI, CCR-EXPANDED, IC Timespan=2000-2015 2 (TI=food) AND **LANGUAGE:** (English) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, ESCI, CCR-EXPANDED, IC Timespan=2000-2015 3 #2 OR #1 Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, ESCI, CCR-EXPANDED, IC Timespan=2000-2015 4 (TI=order*) AND **LANGUAGE:** (English) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, ESCI, CCR-EXPANDED, IC Timespan=2000-2015 5 (TI=service) AND **LANGUAGE:** (English) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, ESCI, CCR-EXPANDED, IC Timespan=2000-2015 6 (TI=delivery) AND **LANGUAGE:** (English) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, ESCI, CCR-EXPANDED, IC Timespan=2000-2015 7 #6 OR #5 OR #4 Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, ESCI, CCR-EXPANDED, IC Timespan=2000-2015 8 (TI=electronic) AND **LANGUAGE:** (English) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, ESCI, CCR-EXPANDED, IC Timespan=2000-2015 9 (TI=computer) AND **LANGUAGE:** (English) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, ESCI, CCR-EXPANDED, IC Timespan=2000-2015 10 (TI=spoken) AND **LANGUAGE:** (English) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, ESCI, CCR-EXPANDED, IC Timespan=2000-2015 11 #10 OR #9 OR #8 Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, ESCI, CCR-EXPANDED, IC Timespan=2000-2015 #11 AND #7 AND #3 Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, ESCI, CCR-EXPANDED, IC Timespan=2000-2015
Science Direct	pub-date > 1999 and TITLE-ABSTR-KEY ((electronic OR computer OR spoken) AND meal AND (order OR ordering OR service OR delivery) AND (health OR hospital OR facility))

ProQuest	all((((electronic OR computer OR spoken) AND meal AND (order OR ordering OR service OR delivery) AND (health OR hospital OR facility))))
Scopus	TITLE-ABS-KEY ((**electronic** OR **computer** OR **spoken**) AND **meal** AND (**order** OR **ordering** OR **service** OR **delivery**) AND (**health** OR **hospital** OR **facility**)) AND PUBYEAR > **1999**
Grey Literature/Handsearching	eMenu eMeal electronic meal ordering electronic menu computer meal order EMO bedside spoken meal order bedside menu

Appendix B: Summary of the literature on the impact of electronic meal ordering on hospital and patient outcomes

Hospital	Type of System	Author (Year); Source Type	Study Design, Duration, and Sample	Outcome Measure(s)	Key Findings	EPHPP Quality Rating
The Prince Charles Hospital, Queensland, Australia	Spoken Menu	O'Hanlon et al. (2010); Conference abstract	Observational study using interviews and surveys Patients and key stakeholders from teaching hospital, relevant contacts from 3 other hospitals (roles unspecified)	Patient satisfaction Impact on staff (satisfaction)	• 37% of patients received default meals • Patient preference was 54% EMO; 26% paper menu; 20% no preference • Food service staff preferred paper menus	Weak
		Neaves (2014); Presentation	Hospital incident report review	Clinical outcomes	• No clinical incidents observed following implementation of EMO with allergy management module	Weak

North York General Hospital (NYGH) and Humber River Regional Hospital (HRRH), Toronto, Canada	Spoken Menu	Dillon et al. (2012); Peer-reviewed journal article	Pre-post cohort study using surveys and interviews	Patient satisfaction Food & cost outcomes (meal accuracy) Impact on staff	• Increased patient satisfaction scores for meal service at from 95% HRRH and 88% NYGH to 99% and 98% respectively post spoken menu implementation • Increased patient satisfaction regarding the degree to which food preferences were respected (from 89% at HRRH to 94% and 77% to 86% at NYGH) • Staff responsible for taking meal orders felt an increase in job satisfaction	Weak
Sturgeon Community Hospital, Alberta, Canada	Spoken Menu	Foreman (2006); Conference abstract	Pre-post cohort study utilising surveys, and plate waste audits Patients	Patient satisfaction Impact on staff	• Increased job satisfaction • Decreased dietician workload regarding patient diet information • Approximately 24% increase in food consumption • Patients enjoyed increased choice of meals	Weak
5 hospitals within the Illawarra Area Health Service, Australia	Spoken Menu	Patch et al. (2003); Peer-reviewed journal article	Cross-sectional observational study at 3 time points (4, 8 and 12 months) using a questionnaire	Food and cost outcomes (meal accuracy)	• 10-30% of those who selected own meals received an incorrect meal • No significant improvements to process of patient meal provision post EMO implementation	Weak

Trillium Health, Toronto, Canada	Spoken Menu	Steele (2008); Presentation Steele (2009); Newsletter	Pre-post cohort study employing surveys and food waste audits 100 patients pre and 71 patients post EMO implementation across 4 care units	Patient satisfaction Food and cost outcomes	• 80% of patients felt the ability to choose meals impacted on satisfaction • 87% recommended continuation of EMO • Patient satisfaction with food quality increased by 10%-19% across various dimensions • Food cost savings of CAD$0.07/patient day • 2% increase in food consumption • Hiring of new staff for collection of patient meal selections • Increased labour for gathering menu selections (4mins/patient/day compared to system selected meals)	Weak
		Ganti (2008); Conference abstract	Pre-post cohort study employing surveys and food production audit All inpatients on 4 hospital units	Patient satisfaction	• Patient rankings of "excellent" and "very good" for meal satisfaction increased by 27% to 43% • 86% of nursing staff and hospitality staff felt that the spoken menu was a value added service and should continue • No impact on food wastage	Weak

St. Michael's Hospital, Toronto, Canada	Spoken Menu	Elliot et al. (2012); Conference poster	Pre-post cohort study Patients	Patient satisfaction Impact of staff	• Mean proportion of patients satisfied with meal service increased from 63.9% to 71.2% • Mean satisfaction increased across a number of food and meal characteristics • An average of 7.7minutes/patient was required to collect meal orders for EMO	Weak
St. Vincent's Private Hospital, Sydney, Australia	Spoken Menu	Maunder et al. (2015); Peer-reviewed journal article	Pre-post mixed methods cohort study including observations and time recordings, surveys, and structured interviews 54 patients pre and 65 patients post implementation across 5 wards	Nutritional outcomes Patient satisfaction Impact on staff	• 84% of participants from paper menu cohort and 82% of EMO cohort rated overall satisfaction as "very good" or "good" • Increased patient energy and protein intake with EMO • No additional nutrition assistant time required using EMO, but direct patient interaction increased from 0.33minutes to 3.55minutes/patient/day • Increased patient awareness of the nutrition assistant role	Moderate

		Lazarus (2011); Presentation Lazarus (2011); Conference abstract	Pre-post cohort observational study and surveys Inpatients and nursing staff	Patient satisfaction Impact on staff	• Letters of commendation increased from 4 to 35 post EMO • Nurses viewed the increased presence of nutrition assistants on the wards favourably • Nurses felt that nutrition assistants provided nutritional advice and education to patients and dealt with meal issues in a prompt manner	Weak
		Maunder et al. (2009); Conference abstract	Pre-post cohort observational study Inpatients across two wards	Nutritional outcomes Impact on staff	• 60% of nutrition staff time spent with patients in EMO model versus 19% in paper model • No difference between nutritional adequacy of meal selections between models • 78% of patients and all nutrition staff preferred EMO	Weak

Mater Private Hospital, Brisbane, Australia	Room Service	News at Mater (2014 and 2015); Hospital newsletter article	Surveys and waste auditing	Food outcomes Patient satisfaction	• Decreased food waste by 15% • Patient satisfaction rankings rose from 35th percentile to 75th percentile • Significant increases in staff satisfaction	Weak
		Global Green and Health Hospitals (2015); Report article	Surveys, interviews, food waste audits	Patient satisfaction Impact on staff	• Improved patient satisfaction • Increased number of chefs throughout the day, offset by a decrease in the total kitchen staff during peak hours	Weak

		McCray (2014); Presentation	Surveys and food audits	Food and cost outcomes Patient satisfaction	• Plate waste reduction from 29% to 12% • 80% to 100% of consumers enjoyed room service and rate it as an improved meal service compared to previous model	Weak
Children's Hospital of Eastern Ontario, Ottawa, Canada	Room Service	Wadden et al. (2006); Peer-reviewed journal article	Pre-post cohort study utilising interviews 40 paediatric oncology and haemodialysis patients	Patient satisfaction	• Statistically significant improvements in patient satisfaction overall, plus regarding specific food properties including quality, temperature, and variety	Moderate

The Hospital for Sick Children, Toronto, Canada	Room Service	Kuperberg et al. (2008); Peer-reviewed journal article	Pre-post observational using questionnaires, recording of food consumption/waste, and micronutrient 54 inpatients across 2 units	Patient satisfaction Nutritional outcomes Food and cost outcomes	• Improved satisfaction of food temperature, perception of food, meal serving times • Reduction in meal costs by 36% at breakfast, 29% at lunch, and 19% at dinner • Reduction in number of meal trays sent • Increased energy (carbohydrates, protein, fat) consumption across all meals, but (statistically) significantly at lunch	Moderate
		Obadia et al. (2010); Peer-reviewed journal article	Retrospective cross-sectional analysis of system data	Nutritional outcomes	• Inpatient children met minimum requirements of 5 serves of fruit and vegetables/day and exceeded 4.5 serves consumed by general paediatric population, but still on lower end of recommendation	Moderate

		Kuperberg et al. (2009); Peer-reviewed journal article	Pre-post observational study	Impact on staff	• Additional 4.1 employees hired to run room service • Room service model brings entire food service team closer to patient care	Weak
Hospital Gelderse Vallei, Ede, Netherlands	Room Service	Doorduijn et al. (2015); Peer-reviewed journal article	Pre and post cohort study using surveys, 337 patients across six wards	Patient satisfaction Nutritional outcomes	• Patient satisfaction increased for room service (statistically significant) • No significant changes in body weight or handgrip strength between groups • Intake of energy and protein did not differ between the two meal groups	Weak

Unspecified	Self Service	Hartwell et al. (2016); Peer-reviewed journal article	Pre-post questionnaire 87 patients pre and 75 patients post across 10 wards	Patient satisfaction	• Most patients used EMO effectively • Patient perception and satisfaction with self-ordering based heavily on support and service standards of staff.	Moderate
Royal Bournemouth Hospital, Bournemouth, United Kingdom	Self Service	Hospedia (2014); Case study	Surveys and other (unspecified) methods	Food and cost outcomes Patient satisfaction	• Decrease in excess meals from 7.5/day to 1.3/day • Decrease in food waste of to under 4% • Cost savings from removal of printed menu cards and labour in menu distribution, collection and scanning • 90% of patients felt the EMO was easy to use.	Weak