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**Impact of electronic bedside meal ordering systems on dietary intake, patient satisfaction, plate waste and costs: A systematic literature review**

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1 The impact of electronic bedside meal ordering systems on dietary intake, patient  
2 satisfaction, plate waste and costs: A systematic literature review.

3

#### 4 **Abstract**

5 **Aims:** Hospital foodservices provides an important opportunity to deliver valuable  
6 dietary support to patients, address hospital-acquired malnutrition risk and enhance  
7 patient satisfaction. Modifying the meal ordering process through the adoption of  
8 technology may actively engage patients in the process and provide an opportunity to  
9 influence patient and organisational outcomes. This systematic review was undertaken to  
10 evaluate the impact of electronic bedside meal ordering systems in hospitals on patient  
11 dietary intake, patient satisfaction, plate waste and costs.

12 **Methods:** A systematic search following PRISMA guidelines was conducted across  
13 MEDLINE, CINAHL, EMBASE and Web of Science for randomised controlled trials  
14 and observational studies comparing the effect of electronic bedside meal ordering  
15 systems with traditional menus on dietary intake, patient satisfaction, plate waste and  
16 cost. The quality of included studies was assessed using the Quality Criteria Checklist for  
17 Primary Research tool.

18 **Results:** Five studies involving 720 patients were included. Given the heterogeneity of  
19 the included studies, the results were narratively synthesized. Electronic bedside meal  
20 ordering systems positively impacted patient dietary intake, patient satisfaction, plate  
21 waste and costs compared with traditional menus.

22 **Conclusion:** Despite the increase in healthcare foodservices adopting digital health  
23 solutions, there is limited research specifically measuring the impact of electronic bedside  
24 meal ordering systems on patient and organisational outcomes. This study highlights

25 potential benefits of electronic bedside meal ordering systems for hospitals using  
26 traditional paper menu systems, while also identifying the need for continued research to  
27 generate evidence to understand the impact of this change and inform future successful  
28 innovations.

29

30 **Key Words:** Patient satisfaction, Foodservices, Technology, Dietary intake, Systematic

31 Review

## 32 **Introduction**

33 There is an increasing focus within the hospital environment to provide quality care that  
34 enhances patient satisfaction and supports positive patient outcomes<sup>1,2</sup>. In the current  
35 consumer-focused environment, hospital services aim to meet increasing patient  
36 expectations while simultaneously managing budgetary constraints and/or increasing  
37 expenses<sup>3,4</sup>. With a duty of care to provide safe, effective and equitable care to patients,  
38 hospitals must achieve this while treating and preventing malnutrition<sup>5</sup>. Hospital  
39 foodservices provide a unique opportunity to influence dietary intake, address  
40 malnutrition risk and subsequent clinical outcomes across the hospital population. In  
41 addition, hospital foodservices are a key point of customer service and have the capacity  
42 to influence patients' perception of their entire hospital experience and enhance their  
43 satisfaction<sup>3,6,7</sup>. Innovative foodservice models that enhance patient experience and  
44 improve dietary intake while reducing waste and remaining cost-effective are therefore  
45 worthy of further investigation.

46

47 A potential tool to address these drivers is the utilisation of technology<sup>8</sup>. While the  
48 adoption of technology in healthcare has been slower than other industries, electronic  
49 foodservice management systems have been increasingly implemented over the last  
50 decade to support food procurement, food preparation, meal ordering and delivery,  
51 allergen management and to enable foodservice model transformations,- delivering  
52 positive patient and organisational outcomes<sup>3,9,10</sup>. Customer-focused technological  
53 innovations that can impact dietary intake and address malnutrition risk through  
54 enabling patients to be active participants in their meal ordering while in hospital, is the  
55 focus of this systematic review. Electronic bedside meal ordering systems (eBMOS) are

56 used by meal ordering staff at the patient bedside on wireless devices, or by patients  
57 using bedside televisions/computers or their own mobile phone, to place their meal  
58 orders<sup>9,10</sup>. Any meals (main or mid-meals) which the facility allows patients to have an  
59 advanced choice can be ordered via the eBMOS. This model is different to a traditional  
60 paper menu method of meal ordering (TM), as it enables real-time patient data,  
61 including diet and allergies, to be available at the time of ordering. It also allows closer  
62 to mealtime ordering due to the data being entered directly into an electronic system  
63 ready for meal tray preparation.

64

65 To date, no systematic reviews have specifically evaluated the impact of eBMOS on  
66 patient and hospital outcomes in comparison to TM. It is important to understand  
67 whether this innovation is successfully delivering the outcomes it was designed to  
68 achieve, independent to the food delivery model, to guide hospitals in determining the  
69 best method for patient meal-ordering. A recently published review assessing the impact  
70 of eBMOS had a broader inclusion criteria for the study design, did not require studies  
71 to include a comparator to the intervention and featured studies with concurrent changes  
72 in the foodservice system, such as a transformation to room service<sup>11</sup>. Room service is  
73 well recognised as a foodservice model that can deliver improvements in hospital and  
74 patient outcomes, and therefore any improvements cannot be directly attributed to the  
75 utilisation of eBMOS. A high-quality review which featured research published 5 years  
76 ago by Ottrey and Porter<sup>3</sup> was also broader in scope than the current review and  
77 explored the effect of different menus and meal ordering systems on outcomes  
78 including dietary intake, cost, satisfaction and meal tray accuracy.

79 The aim of this systematic review was to 1) evaluate current empirical evidence on the  
80 impact of an eBMOS on key outcomes including patient dietary intake, patient  
81 satisfaction, plate waste and cost in comparison to a TM; and 2) review the quality of  
82 these studies using a validated tool. It is anticipated that this systematic review will  
83 provide an evidence-base to uniquely inform future foodservice design relating to  
84 patient meal ordering models to positively benefit patient and organisational outcomes,  
85 as well as drive future research.

86

## 87 **Methods**

88 This systematic literature review was undertaken in line with recommendations of the  
89 Cochrane Handbook for Systematic Reviews of Interventions<sup>12</sup> and reported according to  
90 the Preferred Reporting Items for Systematic Reviews and Meta-Analysis: The PRISMA  
91 statement<sup>13</sup>. The methodology for this review, including pre-specified eligibility criteria  
92 and search strategies, was prospectively registered with the International Prospective  
93 Register of Systematic Reviews (CRD 42017059111).

94

95 A literature search was conducted in the online bibliographic databases MEDLINE (Ovid  
96 interface), CINAHL (EBSCO host interface), EMBASE (Elsevier interface) and Web of  
97 Science (Web of Knowledge portal) from inception to December 2018, with no date or  
98 language restrictions. Combinations of the terms “bedside menu ordering system,”  
99 “menu,” and “hospital food service” were searched for as medical subject headings and  
100 key or free text words. The search strategy is presented as **Online Supplemental**  
101 **Material**. Additional relevant studies were retrieved through additional hand-searching,

102 contacting field experts and searching of ClinicalTrials.gov - a central repository of  
103 clinical trials - to identify ongoing studies.

104

105 Three authors (RN, DS KMS) screened articles in a blinded, standardised manner.

106 Search results were exported to Endnote (X8; Thompson Reuters) and de-duplicated

107 prior to screening using the online screening application Rayyan<sup>14</sup>. Following screening,

108 full-text manuscripts of potentially relevant studies were sought and reviewed. Studies

109 were included if the following criteria was met: 1) prospective or retrospective

110 observational study design, randomised controlled trial (RCT); 2) included adult

111 participants ( $\geq 18$  years of age); 3) took place in an acute healthcare/hospital setting;

112 and 4) compared a new eBMOS with an existing TM. The term “eBMOS” was used by

113 this review to describe an electronic solution for collecting patient meal orders.

114

115 Abstracts and non-peer-reviewed manuscripts were excluded. Studies that implemented

116 and evaluated the use of room service or other broader foodservice model interventions

117 were excluded<sup>15,16</sup>. Interventions that included a simultaneous change in foodservice

118 models were excluded from the analysis as the outcomes could not be attributed to the

119 meal ordering system alone<sup>15-19</sup>. Two reviewers (RN and DS) independently extracted

120 data from included studies.

121

122 Review outcomes included the difference or change from the application of an eBMOS

123 when compared to a comparator/control on the following outcomes: 1) patient dietary

124 intake (defined as the amount of energy [kJ] and protein [g] consumed in a 24-hour period

125 and/or 48-hour period); 2) plate waste (percentage of served food that remains uneaten

126 by the patient<sup>20</sup>; 3) patient satisfaction (a subjective rating of hospital foodservices  
127 quality<sup>21</sup>; or 4) cost (any cost associated with the food served, staff or overall system). A  
128 meta-analysis was not considered appropriate due to the small number of eligible studies,  
129 which measured different outcomes using a range of tools.

130

131 The quality of included studies was evaluated by two independent reviewers (RN and  
132 DS) using the Quality Criteria Checklist for Primary Research tool from the Academy of  
133 Nutrition and Dietetics<sup>22</sup>. To ascertain the presence or absence of threats to the validity  
134 of research, the tool consists of 10 questions encompassing: clarity of the research  
135 question; subject selection; comparability of study groups; handling of withdrawals;  
136 blinding; descriptions of the intervention; validity of outcome measures; appropriateness  
137 of data synthesis; conclusion support; and likelihood of funding bias<sup>22</sup>. Based on these  
138 domains, overall quality ratings of either positive (most validity questions answered yes,  
139 including the first four), neutral (one or more of the first four validity questions assessed  
140 as 'no', but other criteria indicate strengths) or negative (six or more of the domains are  
141 assessed as 'no') would be generated<sup>22</sup>.

142

## 143 **Results**

144 A total of 3076 papers were retrieved from the data base search for inclusion across the  
145 four online databases (Figure 1). Following the removal of duplicate papers ( $n = 805$ ) and  
146 screening abstracts ( $n = 2270$ ), 40 papers were retained for full text screening. One study  
147 was identified through hand-searching, resulting in a total yield of 5 articles included in  
148 this review.

149



150 All studies compared an eBMOS to a TM (Table 1). Three studies evaluated the impact  
151 of a patient-directed eBMOS (terminology including BMOS/e-menu/TV menu)<sup>10,23,24</sup>  
152 and the other two studies reported on staff-deployed eBMOS<sup>9,25</sup>. One study was  
153 conducted using an observational point prevalence approach<sup>23</sup>, with the remainder  
154 conducted using of pre- and post-test study designs<sup>9,24-26</sup> (Table 1). Sample sizes  
155 investigated across included studies ranged from 50 participants to 860 participants.  
156  
157 The effect of eBMOS on dietary intake was reported in three studies. Barrington et al.<sup>23</sup>  
158 found that a patient-directed eBMOS led to significantly higher mean daily energy  
159 intake  $6457 \pm 3069$  kJ vs  $4805 \pm 2028$  kJ ( $p < 0.001$ ) and protein intake  $72.3 \pm 36.7$  g vs  
160  $57.7 \pm 26.9$  g ( $p < 0.001$ ) compared with a TM. Similarly, two staff-deployed eBMOS  
161 models found a significantly higher mean daily energy intake compared with TMs  $8273$   
162  $\pm 2043$  kJ vs  $6273 \pm 1818$  kJ ( $p < 0.001$ )<sup>9</sup>; and  $6232 \pm 2523$  kJ vs  $5513 \pm 2212$  kJ  
163 ( $p = 0.04$ )<sup>25</sup>. Likewise, these two studies also found mean daily protein intake was  
164 significantly higher with eBMOS compared with TMs  $83 \pm 24$  g compared with  $66 \pm 25$   
165 g ( $p = 0.01$ )<sup>9</sup>; and  $78 \pm 36$  g compared with  $53 \pm 24$  g ( $p < 0.001$ )<sup>25</sup>. Further comparisons  
166 of energy and protein intake relative to the estimated requirements of patients (EER and  
167 EPR respectively) were undertaken by Maunder et al.<sup>9</sup> and McCray et al.<sup>25</sup>. In the study  
168 undertaken by Maunder et al., patients receiving eBMOS met, on average, 110%  
169 estimated energy requirements and 105% estimated protein requirements compared with  
170 86% for both using the traditional TM ( $p = 0.01$  and  $p = 0.02$ , respectively)<sup>9</sup>. Similarly,  
171 McCray et al found that significantly more patients receiving eBMOS met their  
172 estimated energy (73% vs 64%;  $p = 0.02$ ) and protein (98% vs 70%;  $p < 0.001$ )  
173 requirements compared with TM<sup>25</sup>.

174

175 Patient satisfaction for the overall hospital foodservice was assessed in three of the five  
176 papers<sup>9,10,25</sup> (Table 2). Two studies showed that staff-deployed eBMOS and TM reported  
177 high, stable scores in overall foodservice patient satisfaction using the Acute Care  
178 Hospital Foodservice Patient Satisfaction Questionnaire; which does not specifically  
179 explore satisfaction with the type of meal ordering system. Maunder et al.<sup>9</sup> reported  
180 patients rating their overall satisfaction as ‘good’ or ‘very good’ at 82% using eBMOS  
181 compared to 84% using the TM ( $p>0.05$ ). McCray et al.<sup>25</sup> also reported patients rating  
182 their overall satisfaction as ‘good’ or ‘very good’ at 74% using eBMOS and 75% with  
183 TM ( $p=1.0$ ). Hartwell et al.<sup>10</sup> evaluated satisfaction in a patient-directed eBMOS  
184 compared to a TM across several domains (including temperature, presentation and ease  
185 of use), and reported the only difference was an increased satisfaction with regard to  
186 having meal ingredient information provided in eBMOS ( $p=0.01$ ).

187

188 Three studies assessed or asked specific additional questions related to patient satisfaction  
189 in regards to the new meal ordering system Jamison et al.<sup>24</sup> found that patients preferred  
190 the eBMOS over the TM on the basis of interest, curiosity, convenience, availability,  
191 satisfaction and motivation ( $p<0.01$ ). When McCray et al.<sup>25</sup> and Maunder et al.<sup>9</sup> surveyed  
192 patients specifically about their menu ordering system preference, they found that  
193 significantly more preferred eBMOS to the TM in both studies; 84% versus 16%  
194 ( $p<0.001$ )<sup>25</sup> and 80% versus 15% with 6% not minding either way ( $p<0.05$ )<sup>9</sup>. Two studies  
195 evaluated the effect of eBMOS on plate waste<sup>23,25</sup>. A patient-directed model<sup>23</sup> found no  
196 significant difference in average daily plate waste between BMOS (34.3%) and TM

197 (35.4%) ( $p=0.75$ ), while a staff-deployed model displayed a significant reduction in plate  
198 waste using eBMOS (30%) compared with TM (26%) ( $p<0.001$ )<sup>25</sup>.

199

200 Costs were evaluated in two studies<sup>24,25</sup>. McCray et al. reported a decrease in total  
201 patient food cost of 19% for eBMOS compared with TM across a comparable 12-month  
202 period<sup>25</sup>. Jamison et al. reported on the cost of effectiveness of implementation of the  
203 eBMOS determined by means of the payback method (i.e. the time required to recoup  
204 the initial investment of their project). Costs were based on labour, software and  
205 printed menu costs for each model. They reported that operating the eBMOS instead of  
206 the TM would result in monthly savings of \$1197 (\$615 per month compared with  
207 \$2093 per month) and an estimated payback period of 8.4 months<sup>24</sup>. They also  
208 suggested additional possible savings could be achieved through a reduction in food  
209 waste due to increased accuracy of forecasting and tallying using the eBMOS.

210

211 The overall quality of included studies was mostly neutral across the five included studies  
212 (Figure 2). The research question was clearly stated by all included studies, as were  
213 intervention descriptions, relevancy of study outcomes, specificity of inclusion criteria  
214 and analyses performed. The characteristics and subsequent comparability of stratified  
215 participant groups was adequately described in four studies<sup>9,10,23,25</sup>, while only one study  
216 discussed and response rates among participant groups<sup>9</sup>. Three of the five included studies  
217 used validated methods to assess study outcomes<sup>9,23,25</sup>. Though the conclusions of each  
218 study were supported by their results, limitations of the research were not considered in  
219 two studies<sup>10,24</sup>. Blinding for outcome assessments was not discussed in any of the  
220 included studies. Based on this risk of bias tool, the overall quality rating of included

221 studies was mostly neutral: only a single study was judged as “positive”<sup>9</sup> with the  
222 remainder assessed as “neutral”<sup>23-26</sup>.

223

## 224 **Discussion**

225 Despite the paucity of literature, this systematic literature review identified studies to  
226 demonstrate that an eBMOS has the potential to improve patient dietary intake and  
227 satisfaction, as well as reduce plate waste and foodservice costs. As healthcare continues  
228 to transition to a digital health environment, technological solutions that support  
229 consumer engagement, as well as provide essential patient and organisational benefits,  
230 will become critical in the future.

231

232 Three studies featured within the systematic review demonstrated that changing to an  
233 eBMOS can increase patients’ dietary intake<sup>9,23,25</sup>, which may consequently contribute to  
234 addressing malnutrition risk and preventing hospital-acquired malnutrition<sup>27,28</sup>. This  
235 study refines the broader findings of complementary systematic reviews<sup>3,7,11</sup>. While very  
236 specific in scope; it enables the opportunity to narrow the impact of other interventions  
237 and support the role of implementing an eBMOS as a core component of contributing to  
238 these positive outcomes. In each of these studies there was a major change in patient meal  
239 order timing, shifting from up to 24 hours in advance to between 1 to 4 hours prior to  
240 meals. Therefore, a potential explanation is that using an eBMOS facilitates patients to  
241 make meal orders closer to the mealtime, when they are more likely to know what they  
242 feel like eating, resulting in increased dietary intake. eBMOS may also enable more  
243 patients to receive their personal selections compared to TM, which is harder to manage  
244 patient dietary and location changes during their admission, and therefore may result in

245 receiving standard default meals. While the calculations adopted for estimating dietary  
246 requirements were different across two studies and could have contributed to the  
247 differences in proportion of percentage of energy and protein requirements achieved<sup>9,25</sup>,  
248 there are other variables that can cause differences across sites, including the menu.  
249 However, the studies used consistent measures in the pre- and post-data analysis within  
250 each study and found a consequent statistically significant increase in both studies of  
251 patients meeting their estimated energy and protein requirements when using eBMOS.

252

253 Patient satisfaction has long been a focus of achieving optimal foodservice models in  
254 healthcare, and systems and processes that encourage increased patient interaction and  
255 involvement with the meal order process have been suggested to improve satisfaction.  
256 This review featured several studies, albeit with small sample sizes, that showed that  
257 patient satisfaction was either maintained or improved after the implementation of  
258 eBMOS. To inform current and future meal ordering system design and to provide  
259 opportunities for research meta-analysis, it may be useful to ensure consistency in use of  
260 a valid and reliable tool for measuring patient satisfaction with foodservices and  
261 specifically measuring satisfaction with the meal ordering process. Validated tools that  
262 measure patient satisfaction e.g. the Acute Care Hospital Foodservice Patient Satisfaction  
263 Questionnaire by Capra et al<sup>21</sup> are excellent to assess overall satisfaction and are often  
264 related to food quality and potentially dietary intake but do not contain specific questions  
265 related to the meal ordering system or process. When surveys were conducted specifically  
266 around the meal ordering process, two studies found that the eBMOS was preferred over  
267 TM<sup>9,25</sup>.

268

269 This ability of eBMOS to support closer to mealtime ordering may also have other  
270 positive effects; for example, it can decrease plate waste as evidenced in two studies  
271 within this review<sup>23,25</sup>. Other points of waste seen within a foodservice model such as  
272 duplicate trays produced for late meal orders due to poor and delayed communication of  
273 orders with a TM may be reduced using an eBMOS, as it enables real-time information  
274 on patient status and meal orders. Oyarazun et al cited ineffective diet-order  
275 communication as a major reason for late trays and accounting for 78% of extra meal  
276 trays required to be produced<sup>29</sup>.

277

278 While it is accepted that costs are a critical control for hospital foodservices, in this review  
279 only two studies reported a cost figure associated with changing their meal ordering  
280 system<sup>24,25</sup>. Additionally, one of these reviews was undertaken in 1996, before significant  
281 technological advancements<sup>24</sup>. These two studies reported on different cost factors, one  
282 in relation to total patient food costs and the other on labour costs and time to take meal  
283 orders. Low costs reporting may be in part related to the fact that this information is  
284 sensitive or can be hard to measure and attribute impact to individual interventions.  
285 Nonetheless further information and clarity around cost measures will assist foodservice  
286 directors and managers to make informed decisions within budgetary constraints and be  
287 able to clearly demonstrate the financial impact of system and process changes<sup>30</sup>.  
288 Interventions that utilise technology to provide improved communication regarding the  
289 meal order may assist in reducing overall waste and therefore costs.

290

291 The main strength of this systematic review were its strict inclusion criteria ensuring that  
292 the intervention was predominantly related to a change to an eBMOS; and that studies

293 with concurrent changes in their distribution system or other major foodservice systems  
294 were excluded. However, there were several limitations which should be considered when  
295 interpreting the findings of this review. A paucity of high-quality studies of robust design  
296 that specifically answered the research question were identified and therefore a narrative  
297 synthesis of key findings was undertaken. Of the five studies that were included, one  
298 study received a positive score<sup>9</sup> while four were assessed as neutral<sup>23-26</sup> using the Quality  
299 Criteria Checklist<sup>22</sup>. A recent systematic review of foodservice interventions found that  
300 only 9 of 33 included studies had sufficient methodologic quality to meet evidence-based  
301 scientific standards<sup>7</sup>. Conducting foodservice research in an active hospital setting is  
302 challenging, however investment in high quality, published foodservice research is  
303 essential to demonstrate the potential impact of foodservice innovations in influencing  
304 patient and organisational outcomes<sup>7,9,27</sup>.

305

306 This review provides the many hospitals utilising a TM evidence that transitioning to an  
307 eBMOS have the potential to improve dietary intake, patient satisfaction, plate waste and  
308 foodservice costs. There are now a range of cost-effective technologies available to  
309 facilitate this process. As hospitals increasingly investigate technological opportunities to  
310 enhance their operation, communicating with facilities that have previously made similar  
311 changes, and piloting solutions can help to inform the feasibility, and manage risk<sup>7</sup>. In  
312 addition, encouraging a research culture within foodservice dietetics, implementing  
313 system changes and innovations within a research framework, and collecting pre- and  
314 post- implementation data using validated tools will continue to generate valuable  
315 evidence to inform future foodservice system interventions.

316

317 *The lead author affirms that this manuscript is an honest, accurate, and transparent*  
318 *account of the study being reported. The reporting of this work is compliant with*  
319 *PRISMA guidelines. The lead author affirms that no important aspects of the study have*  
320 *been omitted and that any discrepancies from the study as planned.*

321

### 322 **Conflict of Interest**

323 Kristen MacKenzie-Shalders: None to declare.

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338

### 339 **Authorship contribution**

340



341 K MacKenzie-Shalders: Study design and concept, study protocol, second reviewer  
342 search screening, manuscript completion and submission, revisions.  
343 K Maunder: Study design and concept, study protocol, critical analysis and revision of  
344 manuscript.  
345 D So: Systematic literature search and screening, data extraction, risk of bias, revision  
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347 R Norris: Study protocol, systematic literature search and screening, data extraction,  
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352

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357

358

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457 **Search strategies**458 December 15<sup>th</sup>, 2018

459

460 ***MEDLINE via Ovid***461 (menu\*.tw. OR eMenu\*.tw. OR ((food OR meal\*) and order\*).tw. OR Meals/ OR  
462 catering service\*.tw. OR hospital food service\*.tw. OR meal ordering system\*.tw.)

463 (BMOS.tw. OR bed?side.tw OR spoken.tw OR electronic.tw. OR informatics.tw. OR

464 system.tw. OR wireless.tw. OR computer\*.tw. OR monitor.tw. OR digital.tw. OR exp  
465 Food Service/ OR exp Hospitals/)

466 (acute.tw. OR hospital\*.tw. OR hospital patient\*.tw.)

467 **Results: 853**

468

469 ***Excerpta Medica Database (EMBASE) via Elsevier***470 (menu\*:ti,ab OR eMenu\*:ti,ab OR ((food OR meal\*) AND order\*):de OR 'meal'/exp OR  
471 'catering service'/exp OR 'hospital food service'/exp OR 'meal ordering system'/exp)

472 (BMOS:ti,ab OR bedside:ti,ab OR 'bed side':ti,ab OR spoken:ti,ab OR electronic:ti,ab

473 OR informatics:ti,ab OR system:ti,ab OR wireless:ti,ab OR computer\*:ti,ab OR

474 monitor:ti,ab OR digital:ti,ab)

475 (acute:ti,ab OR hospital\*:ti,ab OR 'hospital patient\*':ti,ab)

476 **Results: 958**

477

478 ***Cumulative Index to Nursing and Allied Health Literature (CINAHL) via EBSCO***479 ***host***480 (menu\* OR eMenu\* OR ((food OR meal\*) AND order\*) OR (MH "Meals") OR (MH  
481 "Menu Planning") OR (MH "Food Service Department") OR meal ordering system\*

482 BMOS OR bedside OR "bed side" OR spoken OR electronic OR informatics OR

483 system OR wireless OR computer\* OR monitor OR digital

484 acute OR hospital\* OR (MH "Inpatients") OR "hospital inpatient\*")

485 **Results: 270**

486

487 ***Web of Science via Web of Knowledge***488 TI=((menu\* OR eMenu\* OR ((food OR meal\*) AND order\*) OR meal\* OR catering  
489 service\* OR hospital food service\* OR meal ordering system\*)) OR AB=((menu\* OR

490 eMenu\* OR ((food OR meal\*) AND order\*) OR meal\* OR catering service\* OR

491 hospital food service\* OR meal ordering system\*))

492 TI=((BMOS OR bedside OR bed side OR spoken OR electronic OR informatics OR

493 system OR wireless OR computer\* OR monitor OR digital)) OR AB=((BMOS OR

494 bedside OR bed side OR spoken OR electronic OR informatics OR system OR wireless

495 OR computer\* OR monitor OR digital))

496 TI=((acute OR hospital\* OR hospital inpatient\*)) OR AB=((acute OR hospital\* OR

497 hospital inpatient\*))

498 **Results: 995**

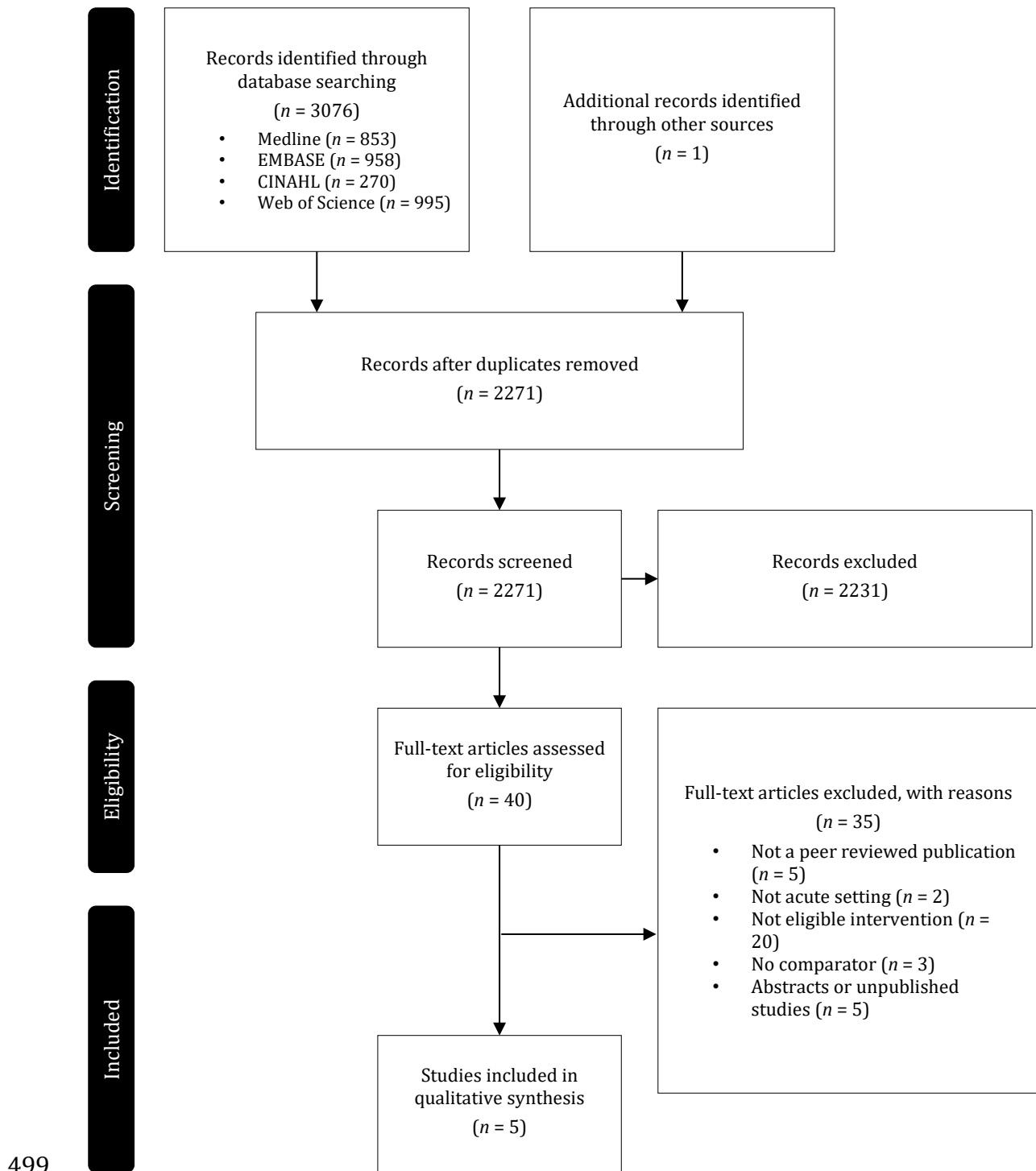


Figure 1. PRISMA Diagram: Flowchart of studies included in the systematic review

	1. Clear research question?	2. Participant selection bias?	3. Comparable study groups?	4. Handling of withdrawals?	5. Blinding	6. Intervention description	7. Valid outcome assessments?	8. Appropriate statistical analysis?	9. Appropriate conclusions?	10. Funding disclosure	Overall quality rating
Barrington 2018	+	+	+	?	?	+	+	+	+	+	?
Hartwell 2016	+	+	+	?	?	+	?	+	?	?	?
Jamison 1996	+	+	?	?	?	+	?	+	?	?	?
Maunder 2015	+	+	+	+	?	+	+	+	+	+	+
McCray 2018	+	+	+	?	?	+	+	+	+	+	?

501

502 *Figure 2 – Quality Criteria Checklist and overall rating for each study included in this*  
 503 *systematic review (n = 5). Risk of bias judgments performed per Primary Research*  
 504 *Quality Criteria Checklist for Primary Research tool from the Academy of Nutrition*  
 505 *and Dietetics*<sup>22</sup>. *Plus/positive ratings presented as green/low; neutral ratings presented*  
 506 *as yellow/unclear, minus/negative ratings presented as red/high.*

This is the peer reviewed version of the following article: MacKenzie-Shalders, K., Maunder, K., So, D., Norris, R., & McCray, S. (2020). Impact of electronic bedside meal ordering systems on dietary intake, patient satisfaction, plate waste and costs: A systematic literature review. *Nutrition and Dietetics*, which has been published in final form at <https://doi.org/10.1111/1747-0080.12600>. This article may be used for non-commercial purposes in accordance with Wiley Terms and Conditions for Use of Self-Archived Versions

Table 1 – Characteristics table of studies evaluating the impact of electronic bedside menu ordering systems on foodservice and patient outcomes with a comparator

Author (year)	Country	Duration <sup>1</sup>	Cohort age <sup>2</sup> (years)	<i>n</i>	Study design	Aim	Intervention; Delivery	Comparator	Reported Outcomes
Barrington et al. (2018)	Australia	NA	Intervention: 65 Comparator: 61	201	Observational point prevalence	To determine changes in patient dietary intake, plate waste and meal experience associated with the implementation of a patient directed BMOS compared to traditional paper menus.	BMOS; Patient-directed	Paper menu	Nutritional intake Plate waste Meal experience
Hartwell et al. (2016)	UK	NA	68	162	Pre-test post-test	To evaluate an initiative in which e-menus and touch screen technology were piloted in a large UK hospital.	E-menu; Patient-directed	Paper menu	Patient Satisfaction
Jamison et al. (1996)	USA	NA	7-78	50	Pre-test, post-test	To evaluate patient acceptability and cost-effectiveness of a computerised menu selection system compared with that of a printed menu system.	Computerised menu (TV screen); staff-deployed	Paper menu	Patient Satisfaction (acceptability) Cost effectiveness
Maunder et al. (2015)	Australia	4	65	119	Quasi-experimental pre-test post-test	To determine changes in the dietary intake and satisfaction of hospital patients, as well as the role of the NA, associated with the implementation of an electronic BMOS compared to a paper menu.	BMOS; staff-deployed	Paper menu	Nutritional Intake Patient Satisfaction
McCray et al. (2018)	Australia	NA	Intervention: 72 Comparator: 63	188	Observational point prevalence	To evaluate the impact of changing from a traditional paper menu ordering system to BMOS on key outcome measures of nutritional intake, plate waste, and the satisfaction of both patients and staff	BMOS; staff-deployed	Paper menu	Nutritional intake Patient satisfaction Plate waste Food costs

<sup>1</sup> Intervention duration in weeks; not applicable in study conducted using pre-test, post-test study designs. <sup>2</sup> Age expressed in mean years of each group; age range provided when means were not obtainable; age expressed as entire cohort where per group data was not available.

Abbreviations: BMOS, Bedside Menu Ordering System; E-menu, Electronic menu; N/A, Not applicable; TV, Television.



Table 2 – Summary of studies evaluating the effect of electronic bedside meal ordering systems on patient satisfaction.

Author (year)	Intervention	Patient Satisfaction Tool	Tool Validity	Satisfaction of intervention Group (%)	Satisfaction of Comparator Group (%)	Overall Satisfaction <sup>1</sup>
Barrington et al. (2018)	Patient-directed BMOS	KCFSQ	Y	46	54	NA <sup>2</sup>
Hartwell et al. (2016)	E-menu	10-question survey	N	NA-	NA	NA <sup>2</sup>
Jamison et al. (1996)	Computerised menu	Two-page survey	N	76	24	↑; P < 0.01
Maunder et al. (2015)	BMOS <sup>5</sup>	ACHFPSQ; Meal Selection Survey	Y; N	82	84	→; P > 0.05
McCray et al. (2018)	BMOS	ACHFPSQ; Meal Selection Survey	Y; N	65	35	→; P > 0.05

<sup>1</sup> Reported between group differences in patient satisfaction with overall hospital foodservice system. <sup>2</sup> Between group differences in patient satisfaction not assessed. Abbreviations: ACHFPSQ, Acute Care Hospital Foodservice Patient Satisfaction Questionnaire; BMOS, Bedside Menu Ordering System; E-menu, Electronic menu; KCFSQ, King's College Food Service Questionnaire; NA, Not applicable; N, No; Y, Yes.