Clinical Decision Support Systems Applied to the Management of Breast Cancer Patients: A Scoping Review

Natallia NOVIKAVA[a,1], Akram REDJDAL[a], Jacques BOUAUD[b,a] and Brigitte
SEROUSSI[a,c,d]

[a] *Sorbonne Université, Université Sorbonne Paris Nord, INSERM, Laboratoire
d'Informatique Médicale et d'Ingénierie des connaissances en e-Santé, LIMICS,
F-75006 Paris, France*
[b] *AP-HP, DRCI, Paris, France*
[c] *AP-HP, Hôpital Tenon, Paris, France*
[d] *APREC, Paris, France*

Abstract. Breast cancer is the most commonly diagnosed cancer worldwide, and its
burden has been rising over the past decades. A significant advance in healthcare is
the integration of Clinical Decision Support Systems (CDSSs) into medical practice,
which support healthcare professionals improving clinical decisions, leading to
recommended patient-specific treatments and enhanced patient care. Breast cancer
CDSSs are thus currently expanding, whether applied to screening, diagnostic,
therapeutic or follow-up tasks. We conducted a scoping review to study their
availability and use in practice. Except risk calculators, very few CDSSs are
currently routinely used.

Keywords. Decision support systems, clinical decision support systems, breast
cancer, scoping review

1. Introduction

Breast cancer is the most commonly diagnosed cancer type, accounting for 1 in 8 cancer
diagnoses worldwide. This trend is not to decrease with more than 3 million new cases
per year (+ 40%) by 2040 and more than 1 million deaths per year (+ 50%) [1]. One of
the opportunities and challenges to improve care quality is the integration of clinical
decision support systems (CDSSs) into the process of medical care provision. However,
although breast cancer is one of the cancers with the best prognosis, we still need accurate,
adapted and cutting-edge CDSSs to assist the decision-making process. Numerous
reviews of the literature on the CDSSs used in the cancer domain have been published
[2-4], among which some are specifically focused on breast cancer [5]. Breast cancer
CDSSs may be applied to patient screening, diagnostic, therapeutic, or follow-up
management. Because the most complex task is undoubtedly the therapeutic
management of breast cancer patients, given the complexity of the drugs and protocols

---

[1] Corresponding Author: Natallia NOVIKAVA, Sorbonne Université, Université Sorbonne Paris Nord,
INSERM, Laboratoire d'Informatique Médicale et d'Ingénierie des connaissances en e-Santé, LIMICS, F-
75006 Paris, France. Email: nataly.novikova05@gmail.com.

used, we conducted a scoping review to study published CDSSs supporting the therapeutic management of breast cancer patients and assess whether they were currently actually used in routine.

2. Methods

We performed a literature search, using PubMed, to retrieve papers published between 2000 and 2023, describing CDSSs applied to breast cancer management. We started by using the following query «decision support systems» AND «breast cancer». Then we filtered the results to keep papers having the two terms in titles or abstracts. We focused on articles about CDSSs that support treatment decisions. The following exclusion criteria were thus applied: (i) CDSSs focused on breast cancer screening; (ii) studies that use CDSSs to support all types of image analysis for diagnosis; (iii) studies that use CDSSs to support genetic analysis or biomarker discovery decisions, excluding treatment decisions; (iv) CDSSs applied to specific groups of patients (e.g. geriatric patients); (v) papers available only in the form of abstracts because of insufficient details. Once we excluded the non-relevant papers, we added the relevant articles we found in the references of selected articles. Finally, an analysis of the selected papers was done to categorize CDSSs according to their objective and checking whether they were used or not in clinical routine. The main categories we selected to classify the systems are:

- Risk calculators (**RCs**): systems that use predictive modeling to provide a probability concerning the positive impact of a treatment on the survival rate or calculating the 5-year or lifetime risk of developing a new breast cancer.
- Therapeutic decision support: systems that provide a patient-specific care plan. We distinguish three main categories: **a)** guideline-based decision support systems **(GB-DSSs)**, **b)** systems that enable the detection of eligibility criteria **(EC)** to clinical trials, **c)** mix systems that combine different methods.

3. Results

The results of the literature research are displayed in Figure 1. From an initial result of 201 articles, a total of 17 articles were finally selected at the end of the review.
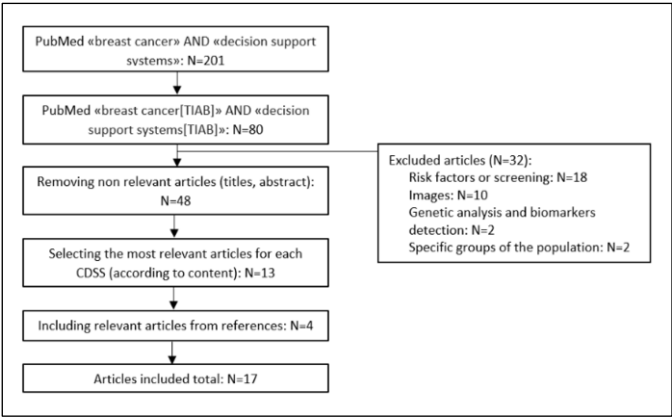

Figure 1 Flowchart of the selection of study articles

These 17 articles refer to 15 different CDSSs. A full view of the analysis is presented in Table 1 (with URP used to denote Used in Routine Practice).

Table 1. Retrieved clinical decision support systems.

Name	Description	Type	URP	Links
Adjuvant!	Estimates the benefit to undergo adjuvant treatment	RC	Yes	www.adjuvantonline.com https://pubmed.ncbi.nlm.nih.gov/11181660/
Cancer-LinQ (CLQ)	Compares the effectiveness and the value of treatment options	Mix: GD-DSS & EC	Yes	www.cancerlinq.org https://pubmed.ncbi.nlm.nih.gov/23714566/ https://pubmed.ncbi.nlm.nih.gov/33104389/
Cancer Math	Estimates the risk of the reduction in life expectancy and survival rate at 15 years	RC	Yes	www.lifemath.net/cancer https://pubmed.ncbi.nlm.nih.gov/21327471/
CLA-RIFY	Estimates possible treatment response and toxicity, stratifies patients	Mix: RC & patient profiling	No	www.clarify2020.eu https://pubmed.ncbi.nlm.nih.gov/36011034/
CTS5 Calculator	Estimates the risk of late distant recurrence (after 5 years of endocrine treatment)	RC	NA	www.cts5-calculator.com https://pubmed.ncbi.nlm.nih.gov/29676944/
DE-SIREE	Proposes appropriate treatment options using 3 decision-support modalities	Mix	No	www.desiree-project.eu https://pubmed.ncbi.nlm.nih.gov/32972655/
MATE	Proposes treatment recommendations, and identifies eligible patients for recruitment into clinical trials	Mix : GD-DSS & EC	Yes	https://pubmed.ncbi.nlm.nih.gov/22734113/
ONCO-assist	Estimates benefits of treatment options after breast cancer surgery	RC	Yes	www.oncoassist.com https://pubmed.ncbi.nlm.nih.gov/31066710/
OncoCure	Proposes most optimal treatment after breast cancer surgery	GB-DSS	Yes	www.cvast.tuwien.ac.at/projects/OncoCure https://pubmed.ncbi.nlm.nih.gov/25063336/
OncoDoc & OncoDoc2	Assists the decision-making process by proposing the most optimal recommended care plans	GB-DSS	Yes	http://ics.limics.upmc.fr/m2ibm-sad/oncodoc2/interface-limited.html https://pubmed.ncbi.nlm.nih.gov/11259883/ https://pubmed.ncbi.nlm.nih.gov/18693918/
Onco-Guide	Assists the decision-making process by proposing the most optimal treatment options	GB-DSS	Yes	www.oncoguide.nl https://pubmed.ncbi.nlm.nih.gov/31141422/
PRE-DICT	Estimates survival rates of treatment options after breast cancer surgery	RC	Yes	www.breast.predict.nhs.Puk https://pubmed.ncbi.nlm.nih.gov/20053270/
RCB Calculator	Help estimate the Residual Cancer Burden (RCB) score after neoadjuvant treatment	RC	Yes	www3.mdanderson.org/app/medcalc/?pageName=jsconvert3 https://pubmed.ncbi.nlm.nih.gov/35976643/
Watson (WfO)	Proposes optimal treatment options	GB-DSS	Yes	https://pubmed.ncbi.nlm.nih.gov/33707577/ https://pubmed.ncbi.nlm.nih.gov/29324970/

From these 15 systems, 6 are based on risk calculation, 5 are strictly guideline-based and provide treatment plan recommendations, and 4 are mixed systems, among which 2 (CancerLinQ and MATE) combine a guideline-based system and an eligibility criteria identification module, another one (CLARIFY) combines risk calculation algorithms and patient profiling techniques, and one (DESIREE) combines guideline-based, cased-based and experience-based decision support to provide treatment recommendations.

4. Discussion

We wanted to check whether these systems had been or were used in routine practice or not. Most risk calculators (Cancer Math, Residual Cancer Burden Calculator, OncoAssist, Adjuvant! and PREDICT) were or are used in routine practice (Adjuvant! has been replaced by PREDICT). These systems are accessible online, they are freely available as stand-alone systems needing few data to operate, which makes it easy for clinicians to use them for risk assessment.

On the other hand, guideline-based CDSSs together with mixed systems are less used in clinical routine. DESIREE and CLARIFY are not yet used especially because of interoperability issues with EHRs. For the same reason, some systems like OncoDoc and its updated version OncoDoc2 have been used in clinical practice for several years, resulting in the increase of clinician decision compliance with guidelines. However, developed as stand-alone systems, they are no more used. Other systems providing care plan recommendations like MATE, OncoCure and OncoGuide have a limited use in few hospitals. The Watson for Oncology program was interrupted because the tool was accused of making inaccurate and unsafe recommendations.

One of the most important key factors for CDSSs being routinely used is their acceptance by healthcare professionals. Factors such as effectiveness, ease of use and user-friendly interfaces play a major role in the adoption. An equally important reason is the absence of the need to re-enter patient data into the CDSS, i.e. CDSSs have to be interoperable with EHRs. Likewise, it might be appropriate to provide an explanation module particularly for CDSSs using AI and machine learning methods to promote transparency and increase the confidence of healthcare professionals in using them.

References

[1] Arnold M, Morgan E, Rumgay H, Mafra A, Singh D, Laversanne M, et al. Current and future burden of breast cancer: Global statistics for 2020 and 2040. The Breast. 2022 Dec;66:15–23.
[2] Pawloski PA, Brooks GA, Nielsen ME, Olson-Bullis BA. A Systematic Review of Clinical Decision Support Systems for Clinical Oncology Practice. J Natl Compr Canc Netw. 2019 Apr;17(4):331–8.
[3] Voigt W, Trautwein M. Improved guideline adherence in oncology through clinical decision-support systems: still hindered by current health IT infrastructures? Curr Opin Oncol. 2023 Jan;35(1):68–77.
[4] Klarenbeek SE, Weekenstroo HHA, Sedelaar JPM, Fütterer JJ, Prokop M, Tummers M. The Effect of Higher Level Computerized Clinical Decision Support Systems on Oncology Care: A Systematic Review. Cancers. 2020 Apr 22;12(4):1032.
[5] Mazo C, Kearns C, Mooney C, Gallagher WM. Clinical Decision Support Systems in Breast Cancer: A Systematic Review. Cancers. 2020 Feb 6;12(2):369.