



**Arab American University**  
**Faculty of Graduate Studies**

**Clinical Decision Support System for Determining the Stages  
to Access Diagnosis, and Suggest a Protocol for Breast Cancer  
Treatment**

By

**Asma'a Khalil**

**Supervisor: Dr. Yusuf Mimi**

**Co-Supervisor: Prof. Mohammed Awad**

**This Thesis was submitted in Partial Fulfillment of the  
Requirements for the Master's Degree in Health  
Informatics**

**January 2022**

**©Arab American University – Jenin 2022**

**All rights reserved**

**Clinical Decision Support System for Determining the Stages to Access  
Diagnosis, and Suggest a Protocol for Breast Cancer Treatment**

Prepared by

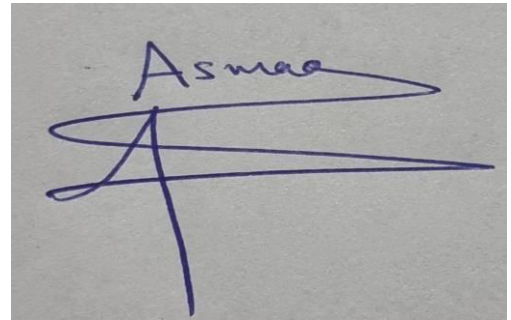
**Asma'a Khalil**

تمت مناقشة الرسالة المذكورة أعلاه في تاريخ 16-2-2022 في قاعة رقم المدرج الريحان/رام الله وكانت نتيجة الطالب هي إجراء تعديلات على الرسالة. وبعد إجراء التعديلات ضمن الفترة الزمنية المسموح بها اطلعت لجنة المناقشة على الرسالة حيث قام الطالب بإجراء جميع التعديلات المطلوبة التي أقرتها لجنة المناقشة.

التاريخ	التوقيع	الاسم	أعضاء اللجنة
2022/6/8		د. يوسف ميمي	المشرف الرئيسي/رئيس اللجنة:
2022/6/8		د. محمد عوض	المشرف المشارك (إن وجد):
2022/6/9		د. محمد الدثت	المتحن الخارجي:
2022/6/8		د. احمد عويس	المتحن الداخلي:

## Dedication

I am so grateful to my parents, family, supervisors, and friends who supported me strongly to achieve the desired results of this research. Thus; I dedicate this work to them.

A handwritten signature in blue ink on a light gray background. The name "Asmaa" is written in a cursive style at the top. Below it, there are several horizontal and vertical strokes that form a stylized, abstract signature.

## Acknowledgments

I am very grateful to my parents, brothers, husband, children, and friends who have supported me morally. I also thank the supervisors, “Dr. Yousef Al-Mimi “and“ Professor “Mohammed Awad”, who helped me achieve the objectives of the study. In addition, I would like to thank my fellow computer programmer “Walid Ayesh”, who designed the Clinical Decision Support System and helped me to accomplish this wonderful project; also, I do not forget the oncologists at Beit Jala Governmental Hospital and Jenin Governmental Hospital. I especially thank “Dr. Nidal Al-Jebreni”.

## Abstract

Breast cancer is one of the most common cancers. However, it is considered the most treatable and life-saving disease, especially when early examinations are performed. Mortality rates are declining as a result of early diagnosis and better treatment. Oncologists need precise tools to help to guide clinical decisions, improve patient survival, promote better quality of health care, and reduce patient burdens, such as high costs, time, and effort, due to the medical complexity of breast cancer, limited physician time, and the need to make decisions in an evidence-based decision-making environment.

In this study, a Clinical Decision Support System (CDSS) has been developed due to the growing need for decisions, at different stages of the patient's clinical journey, such as diagnosis, treatment, and monitoring, to help oncologists to identify, diagnose disease stages, conclude, and suggest possible treatment protocols that are appropriate. The stage after filtering the chemotherapy and hormonal treatment protocols in a scientific way proposed by internationally accredited guidelines (NCCN GUIDELINE), which makes the oncologist rely on this program as a single source instead of referring to many sources, programs, medical dictionaries, or the internet,

so that the oncologist's task is to choose the best treatment for the patient and reduce medical error.

After months and years of using this system, it may provide a treatment plan capable of giving the best results, and arranging these protocols according to the most used and successful, because the system includes the feature of evaluating each treatment protocol after the sessions, as well as arranging and organizing the information entered into the system and including all the characteristics and parameters. The disease and its automatic retrieval through an automatic report that appears in an ascending order that tells the patient's details from the first to the last visit. The clinical decision support system was tested by entering 95 patients and training doctors to use it in the work environment at Beit Jala Governmental Hospital. After adopting the proposed system by a health institution specialized in cancer in Palestine, the researcher recommends developing the system in the future to include all types of cancers. It also hopes to implement it in all Palestinian Ministry of Health hospitals.

## Table of Contents

Dedication .....	III
Acknowledgments .....	IV
Abstract .....	V
Table of Content .....	VII
List of Figures .....	XII
List of Tables .....	XIII
List of Abbreviations .....	XIV
Chapter One: Introduction .....	1
1.1 Research Problem .....	3
1.2 Objectives of the Study .....	5
1.3 Research Questions .....	5
1.4 Expected Outcomes .....	6
1.5 Significance of the Study .....	6
Chapter two: Literature Review and Background .....	8
2.1 Introduction .....	8
2.2 Literature Review: .....	8

2.3 Background.....	11
2.3.1. Breast Cancer .....	11
2.3.2 Kinds of Breast Cancer .....	14
2.3.2.1 According to Site .....	14
2.3.2.1.1 Non-Invasive Breast Cancer:.....	14
2.3.2.1.2 Invasive Breast Cancer: .....	14
2.3.2.2 .Frequently Occurring Breast Cancer: .....	14
2.3.2.2.1 Infiltrating Lobular Carcinoma (ILC): .....	15
2.3.2.2.2 Infiltrating Ductal Carcinoma (IDC): .....	15
2.3.2.3 Less Normally Happening Breast Malignant Growth .....	16
2.3.2.3.1 Modularly Carcinoma:.....	16
2.3.2.3.2 Mutinous Carcinoma: .....	16
2.3.2.3.3 Cylindrical Carcinoma:.....	16
2.3.2.4 Inflammatory Breast Malignant Growth .....	16
2.3.2.5 Paget's Illness of the Nipple .....	16
2.3.2.6 Phyllodes Tumor.....	17
2.3.3 Causes of Breast Cancer .....	17
2.3.3.1 Critical family History .....	17
2.3.3.2 Hereditary Causes.....	17
2.3.3.3 Hormonal Causes.....	17
2.3.3.4 Way of Life and Dietary Reason .....	18
2.3.3.5 Environmental Reason.....	18
2.3.4 Sign and Symptoms of Breast Cancer .....	18
2.3.5 Screening/Diagnosis of Breast Cancer .....	18
2.3.6 Stages of Breast Cancer:.....	19
Table(2.1): Stages of breast cancer(Breast Cancer org, 2010) .....	20
2.3.7 Management of Breast Cancer (Sharma, et al., 2010).....	20
6. Augmentation of Tumor Suppressor Genes .....	20
7. Cell-Target Suicide .....	21
8. Chemo protection Approach .....	21
9. Virus-mediated enclitic .....	21
10. Immunomodulation .....	21

2.4 Clinical Decision Support System (CDSS) .....	21
2.5 Functions and Advantages of CDSS.....	23
2.5.1 Hospitals and Healthcare Organizations.....	23
2.5.2 Medication .....	23
2.5.3 Administrative .....	24
2.5.4 Population Health .....	26
2.5.5 Preventive Medicine .....	27
2.5.6 Patient Safety .....	31
2.5.7 Clinical Management.....	32
2.5.8 Cost Containment .....	33
2.5.9 Administrative Functions .....	34
2.5.10 Diagnostics Support.....	34
2.5.10.1 Diagnostics Support: Imaging .....	35
2.5.10.2 Diagnostics Support: Laboratory and Pathology.....	37
2.5.10.3 Patient-Confronting Decision Support .....	37
2.6 Challenges of CDSS .....	39
2.6.1 Divided Work Processes.....	39
2.6.2 Alert Fatigue and Inappropriate Alerts .....	39
2.6.3 Impact on User Skill.....	40
2.6.4 System and Content Maintenance .....	41
2.6.5 Financial Challenges.....	43
Chapter Three: Research Methodology .....	44
3.1 Introduction	44
3.2. Study Design .....	44
3.3 Study Settings .....	45
3.4 Study Tools	46
3.5. Research Population and Sampling Method.....	47
3.6. System Management and Analysis Framework: .....	48
3.6.1 Study the Characteristics of Breast Cancer Disease: .....	49
3.6.2 Analyze and Design Database .....	50
3.6.3 Create Clinical Decision Support System (CDSS).....	52
3.6.4 Testing and Training for CDSS .....	53

3.6.5 Evaluation of the system through interviews with experts (oncologists):.....	53
<b>3.7. Ethical Considerations: .....</b>	<b>53</b>
Chapter Four: Results .....	54
4.1 Introduction.....	54
4.2. Experimental Results: .....	54
<b>4.3 Evaluation CDSS System Qualitative Analysis: .....</b>	<b>62</b>
4.3.1 Strengths & Advantages of the Proposed System (CDSS).....	62
4.3.2 CDSS’s Mechanism of Raising the Level and Quality of the Services.....	65
4.3.3 The role of CDSS in Monitoring and Follow up .....	66
4.4 Evaluation of CDSS System Results (QuantitativeAnalysis).....	68
Chapter Five: Discussion .....	75
5.1 Introduction.....	75
5.2 Discussion of Results.....	75
5.3 Comparison Between Current Health Information System and CDSS System.....	78
5.3.1 Comparison between CDSS, and the Avicenna system .....	<b>79</b>
Chapter Six: Conclusionsand Recommendations .....	82
6.1 Introduction.....	82
6.2 Conclusions.....	82
<b>6.2.1 Strengths of the Study .....</b>	<b>83</b>
6.3 Recommendations.....	84
6.4 Further Work.....	85
6.5 Study Limitations.....	85
REFERENCES .....	86
Appendix.....	100



<b>List of Figures</b>		
No of Figure	Description	No of Page
Figure 2.1	Structure of breast	13
Figure 2.2	Typical Structure associated with ductal carcinoma	15
Figure 2.3	Various approaches for diagnosis of breast cancer	19
Figure 2.4	Source AHRQ National Scorecard Estimates from Medicare Patient Safety Monitoring System, National Healthcare Safety Network, and Healthcare Cost and Utilization Project	24
Figure 2.5	key associations in knowledge based and non-knowledge based CDSS	30
Figure 3.1	Flow Chart for detect and diagnose.	45
Figure 3.2	System Management and Analysis Framework	49
Figure 3.3	Database Diagram for Diagnosis Breast Cancer.	51
Figure 4.1	Patient Information screen	55
Figure 4.2	Visits Screen	56
Figure 4.3	Symptoms and Diagnosis Screen	57
Figure 4.4	Questionnaire screen	58
Figure 4.5	CDSS Screen	58
Figure 4.6	Treatment plan screen	59
Figure 4.7	Apply Sessions Screen	60
Figure 4.8	Drugs Screen	61
Figure 4.9	Smart Report	61
Figure 4.10	Medical Story Report	62

### List of Tables

No of Table	Description	No of Page
Table 2.1	Stages of breast cancer	20
Table 4.1	Statistical Analysis: Mean Scale	69
Table 4.2	Statistical Analysis: Means and Standard Deviations of CDSS Advantages	71-73
Table 4.3	Statistical Analysis: Means & Standard Deviations of Previous System Disadvantages	74
Table 5.1	Comparison between CDSS, and the Avicenna system	79-81

## List of Abbreviations

Abbreviations	Description
CDSS	Clinical Decision support system
CPOE	computerized provider order entry
EHR	electronic health records
PHR	Personal Health Record
TNM	size of the tumor(T), number of lymph nodes(N), and spreading factor metastatic (M)
ICD-O-3	International Classification of Diseases Oncology 3 (Pathological)
BSA	body surface area
NCCN	National Comprehensive Cancer Network guidelines
PMOH	Palestinian Ministry of Health
ER	Estrogen Hormone (name of Pathology test)
PR	Progesterone Hormone (name of Pathology test)
Her2	human epidermal growth factor receptor 2(name of Pathology test)
DDI	drug-drug interactions
AI	artificial intelligence
IDC	Infiltrating ductal carcinoma
ILC	Infiltrating lobular carcinoma
DCIS	Ductal carcinoma in situ
LCIS	Lobular carcinoma in situ

## Chapter One: Introduction

Breast cancer is one of the most common cancer diseases. However, it is regarded as the most treatable disease, mainly when early examinations are conducted.(Ghoncheh, et al., 2016). Mortality rates are declining as a result of early diagnosis and improved treatments. Oncologists need precise tools to help guide clinical decisions, improve patient prognosis survival, enhance better healthcare quality, and reduce patients' burdens such as the high costs and time.

A clinical decision support system (CDSS) is proposed to improve medical care conveyance by upgrading clinical choices with focused clinical information, patient data, and other wellbeing data (Osheroff, 2012). A customary CDSS includes software programming intended to be a direct guide to clinical decision-making, in which the attributes of an individual patient are coordinated to an automated clinical information base and patient-explicit evaluations or recommendations are then introduced to the clinician for a decision (Osheroff, 2012). CDSSs today are principally utilized at the place of care, for the clinician to join their insight with data or ideas given by the CDSS. Progressively, nonetheless, CDSS is being created with the capacity to use information and perceptions that cannot be obtained or interpreted by people.

Clinical Decision Support System assists oncologists in deciding the sickness's stages (phases) and analyzing them. The framework plans to propose conceivable therapy conventions fitting the stage, causing the oncologist to depend on this program as a solitary source instead of alluding to numerous sources, programs, clinical dictionaries, or websites. The framework can decide the patient's best therapy in the last stages and lessen the happening of clinical blunder. After months and long stretches of utilizing this framework, it might give a treatment plan ready to give the best outcomes.

CDSS is a three-dimensional framework regarding benefits: (1) patient wellbeing, (2) quality of care, and (3) effectiveness of medical services conveyance. It can improve patient wellbeing by lessening unfavorable occasions, recommending a treatment convention customized to the individual

and better-masterminding tests and prescriptions. Besides, it might improve the quality of care by decreasing specialists' responsibility, permitting them more opportunities for direct patient care (Bright, et al., 2012).

CDSS relies upon information-based frameworks, comprehension of space issues, and deduction or thinking strategies to control this information and take care of issues similarly as a human master would. CDSS can be viewed as an information preparing framework that utilizes computational components, information, rules, and accessible realities to take care of issues. It contains the necessary data for the portrayal of information and the procurement of data, the indication of the outcomes, and their investigation. CDSS offers help for decision-making in a particular space and supports its goal in both multi-parametric issues (Bright et al., 2012).

The proposed CDSS additionally intends to assist oncologists with figuring the therapy stage through a logical condition called Tumor, Node, Metastasis (TNM), seen as the most well-known way that specialists stage breast cancer (Placido, et al., 2017). In January, 2003, new staging system was officially adopted in tumor registries. These stages include size discrimination of microstastases and tumor cells, new identifiers to classify lymph nodes, and new classification metastasis (Singletary, et al., 2002). After deciding the phase of breast cancer, oncologists will decide the fitting determination by leading the necessary tests (Parameters) and selecting an appropriate helpful convention.

A typical subject of every one of the four highlights is that they make it simpler for clinicians to utilize a clinical decision support framework, recommending that a compelling framework limit clinicians' exertion and follow up on framework suggestions (Kawamoto et al., 2005).

Generally, CDSS concentrates on diagnostic proposals and ideas, and some attention on treatment. In any case, after evaluating the past literature, no system consolidates deciding the sickness stage and connecting it to the analysis and the normal therapy for every diagnosis.

## 1.1 Research Problem

There is no specific well-being framework in Palestine for patients with tumors. The present well-being frameworks limit the number of patients indicated by the diagnosis (not satisfactory) and do not record illness and treatment phases. Along these lines, no exact information and data about the number of patients as indicated by the therapeutic stages, treatment phases, explanations behind patients' well-being decline, or the reasons for death. Therefore PMOH services are way behind the rest of the world in programming and technology that could be used for patients' care.

The oncologist needs to allude to a few clinical references and dictionaries to finish breast cancer patients' determination, therapy, and follow-up. First, the oncologist utilizes the framework (TNM) to know the phase of the illness. The oncologist researches the International Classification of Diseases (ICD-O-3) to decide the best diagnosis (WHO, 2013). He, at that point, look in volumes and particular books to pick a treatment convention and ascertain body surface area (BSA) to track down the patient's fitting medication portion as per a particular parameter: the patient's age and weight (Prado et al., 2009).

In this research, a CDSS has been developed to help oncologists make clinical decisions. It gives them all the clinical data and skills. It figures the needed equations, saving time and exertion, and lessening mistakes in analysis and treatment because the illness stage is connected to the diagnosis and treatment, which powers the specialist to pick the probable diagnosis and the proposed treatment within specific expected alternatives.

To identify and assort Breast cancer, an integral system of support for clinical decision-making has been created, comprising of clinical information and therapy conventions dependent on qualities given by people from the clinical area with information on the Breast cancer subject.

This investigation depends on an insightful expert system called (Clinical Decision Support System) for breast cancer. The researcher will help a software engineer in the Palestinian Ministry of Health

to set up and make this system, in view of scientific and clinical information and encounters drawn from medical dictionaries and references. This system will help oncologists decide the treatment stage utilizing a scientific condition called (TNM). At that point, each phase of the sickness will be connected to a restricted, separated group of diagnoses taken from a worldwide categorization framework called International Classification of Diseases–Oncology (ICD-O). Every diagnosis will likewise be connected to therapy conventions completely extracted from trained professionals and clinical books' expertise, whereby oncologists will analyze and treat patients viably, proficiently, and rapidly. This shrewd computerized system will be applied in Bait Jala Governmental Hospital as it is the primary community in Palestine for treating cancer patients, explicitly breast cancer.

When the information is programmed into the system, itemized measurements can be acquired to show the number of patients, the kind of illness, its progression, and the degree of hazard to life. Consequently, the CDSS system will anticipate a successful treatment plan that gives the best treatment results to guarantee to protect patients' lives and preventing the sickness from getting to advanced phases.

Proof-based medication is a clinical practice that utilizes clinical information and verification to settle on a proficient decision in medicine. Information technology services assume an urgent part in utilizing the enormous size of the clinical information included. Moreover, medical services society these days uses clinical rules as another partner to improve clinical decision adequacy. Clinical rules accommodate the reduction of change in medical decision-making, prompting improved clinical results. Accordingly, this paper's goal is twofold. Improving the arrangement and perception of infection explicit, clinical information, and accommodating its quicker and more proficient use while ensuring that consistency shows up in the clinical practice by bringing in clinical rules in decision supportive networks (Deepamalar , 2021).

The Clinical Decision Support System (CDSS) that can gather this clinical ability and data and incorporate it with clinical data holds incredible guarantee for giving precise characterization and ideal controlling and successful treatment alternatives (Alther and Reddy, 2015).

An examination directed in 2011 by a group of researchers (Patkar, et al., 2011), the investigation explained the job of the CDSS as an answer for diagnosing cancer by presenting and embracing the multidisciplinary group model (MDT) in the care of cancer patients to guarantee affinity and provide care with the best proof accessible. Ordinary MDT gatherings have become a standard practice in oncology to settle on quiet administration's primary decision making (giving ideal treatment).

During the 1980s of the most recent century, these gatherings planned to learn and share encounters among oncologists. Better clinical outcomes, at present, oncologists have limited their interests to the shortfall of clinical proof and direction for malignant growth and the CDSS has dissipated these worries (Sartipi, et al., 2011).

## **1.2 Objectives Of The Study**

The main objective of this study is to create a CDSS that helps oncologists get a proper diagnosis and give the best treatment plan for the stage of breast cancer, thus saving time and effort and reducing clinical errors, that could happen during diagnosis and treatment, through the clinical data that are available at the clinical center according to global guidelines. In addition, to obtain detailed insights into the number of patients, type of disease and its progression and level of risk, and order and organization entering the patient's medical information according to the workflow diagram. So that it is easy to refer to and retrieve it efficiently, facilitate the study of the disease, and give predictions about the most successful protocols.

## **1.3 Research Questions**

The study addresses will be the following:

1-What is the master system's job (CDSS) in diagnosing and treating breast cancer?

2-Does the current wellbeing system address every oncologist's issues in diagnosing and treating breast cancer patients?

3-Can exact measurements be extracted about the sorts of treatment conventions utilized and patient results after applying every convention?

4-How may CDSS improve better medical care quality and wellbeing informatics as a whole?

5- Did the clinical decision support system achieve better results and benefits for oncologists in the governmental hospitals?

### **1.4 Expected Outcomes**

The promising CDSS is required to arrange the work in the Breast Cancer Unit and provide us with coordinated, organized, and accurate information. This information will understand the types and stages of the disease and the number of affected patients, sorted by stage and diagnosis. Furthermore, the system (CDSS) proposes that reasonable treatment agreements be used at each stage based on global guidelines (NCCN). It is also sure that this system gives us expectations regarding the best treatment agreement for each stage with the number of cases used for each protocol and the success rate of the protocol with the previous cases, as the system calculates the number of previous cases that used the same protocol. In addition to collecting cumulative information from all visits in an intuitive way (Automatic) for each patient, the system tells it to the doctor in a report called (Patient's Medical Case) through a report button.

### **1.5 Significance Of The Study**

The Palestinian Ministry of Health (PMOH) has carried out a health information system in governmental hospitals since 2009, called the Avicenna System, which stores patients' information in a central server, which is used to embed general information about patients visits (Shawahna, 2019). Consequently, it does not contain particular mathematical equations deciding the phase of breast cancer or doses of medications.

In Palestine, there is a special requirement for an expert system CDSS that supports and assists oncologists with settling on the correct decision rapidly and precisely. This system will empower wellbeing associations to get measurable information for the best therapy and decrease clinical mistakes or even conceivable disappointment from medical service suppliers.

This study aims to give a system that surveys the case under inspection. This promising CDSS system is required to comprehend, create, and oversee innovation and technology in well-being associations more readily.

As this system is, at present, inaccessible in Palestine, it may assist oncologists with defeating numerous challenges they face, save their time and endeavors, acquire the best treatment and give the best medical services quality, and improve the general presentation of the wellbeing area in Palestine.

Since 2009, the Palestinian Ministry of Health has received a computerized wellbeing system and left out with the manual framework set up since 1996. Without a doubt, this electronic system altogether affects the nature of medical services in Palestine by sorting out therapy methods. In any case, the current electronic record comes up short on an arrangement of worldwide restorative conventions for all sicknesses, particularly malignancy. The electronic record helps the specialist pick a diagnosis. However, it does not help the specialist decide the ideal therapy convention. This progression requires a specialist system that interfaces the diagnostic characterization to the therapy.

The CDSS system is a specialist system that partitions the symptomatic stages into classifications and incorporates scientific and valuable information and expertise. The assignment technique proposed by the CDSS system assists oncologists with picking the appropriate treatment protocol, which accomplishes viability in persistent results and expands the nature of care and wellbeing services in general, which we seek to accomplish.

## Chapter two: Literature Review And Background

### 2.1 Introduction

In this chapter, breast cancer and its types will be discussed, as well as the clinical decision support system, its advantages, and challenges.

### 2.2 Literature Review:

Coiera (2003) characterizes the advantages of advanced CDSSs as being three classes: (I) patient wellbeing, (ii) quality of healthcare, and (iii) medical services conveyance proficiency. To start with, CDSSs might conceivably work on understanding safety by lessening unfavorable incidents, recommending solutions custom fitted to the individual, and more productive requesting of tests and medications (Bright et al, 2012; Coiera, 2003). Second, CDSSs may work on quality of care by diminishing clinician's responsibility, which leads to making more time accessible for direct tolerant care (Bright et al, 2012; Coiera, 2003), helping the utilization of clinical pathways and rules by working with the utilization of clinical proof, and upgrading clinical documentation-fundamental for limiting mistakes and augmenting patient fulfillment during decision-production (Bright et al, 2012; Coiera, 2003). Third, CDSSs can move along medical care conveyance effectiveness, diminishing expenses by lessening test duplication, diminishing antagonistic incidents, and inclining toward more affordable however similarly viable generic brands (Bright et al, 2012; Coiera, 2003).

Expected advantages and weaknesses of utilizing CDSSs were distinguished from literature reviews (Coiera, 2003; Mollon et al, 2009). Benefits include: (I) saving time e.g., CDSSs give quick input to clinicians and patients, (ii) saving cash, (iii) a superior comprehension of clinical circumstances for all clients (clinicians, patients, wellbeing service management, among others), (iv) better utilization of assets e.g., CDSSs can help survive issues because of wasteful coding of information, (v) clinical training and education, (vi) proposing elective or extra treatment choices, (vii) make new perspectives, (viii) lessen variety in the quality of healthcare, (ix) advancement and assistance and communication of proficient staff, (x) give control, (xi) further develop decisions, (xii) team work in

clinical staff, (xiii) work with clinical gathering independent decision making, (xiv) give new learning, (xv) capacity to answer quick to unforeseen circumstances, also (xvi) give a review trail and backing research.

CDSSs likewise have a few inconveniences (Coiera, 2003; Mollon et al, 2009), for example, (i) acknowledgment process-CDSSs can be seen as a danger to clinical judgment by certain doctors, there might be an anxiety toward learning or getting out of their usual range of familiarity, or anxiety toward carrying out new innovation or technology; (ii) advance over-dependence on technology, doctors could believe that CDSSs could restrict their opportunity to think; (iii) starting expense e.g., upkeep, backing, and training required; (iv) over-accentuation on decision making, software decisions are centered around thinking about all parts of an issue constantly, which may not be needed in most of the circumstances. To conquer such hindrances, it is critical to satisfactorily train the users to guarantee viable and ideal utilization of CDSSs.

The intricate heterogeneity of breast malignant growth, joined with a developing group of proof of public, and global rules on breast cancer medicines make a perplexing dynamic interaction for both clinicians and patients to settle on informed decision-production on the best adjuvant treatment for individual patients, featuring the requirement for better approaches to settling on treatment decisions in this aspect (Piccart-Gebhart, and Sotiriou, 2007). Shared-decision-making among patients and clinicians can be truly compromised without powerful tools to help comprehension of advantages and dangers for result probabilities. Research in clinical decision help has shown that their utilization can decrease costs, work on quality of care and diminish clinical mistakes in clinical settings (Marcial et al, 2018).

In the review of Mazo et al, 2020, they deliberately looked into the literature distributed between January 2008 and September 2019 on CDSS devices to decide their utility concerning helping breast malignant growth treatment decisions. They considered papers that were published in both English

and Spanish. Each CDSS is portrayed, and an outline of elements is given for relative comparison. Their review showed the sorts of clinical and pathological data sources that advise each of the CDSS yields.

To answer the first question of the study which is to recognize and basically evaluate the utilization of CDSSs in breast cancer and their designated results, obvious proof was found in studies on the adequacy of CDSSs in medical services overall (Shahsavarani, et al, 2015) and explicitly, cardiovascular sicknesses (Njie et al, 2015), pneumonic infection (Fathima, at al, 2014), chronic injuries (Schaarup, et al, 2018), prescribed drugs (Hemens, et al, 2011) and prostate malignant growth treatment (Van Wik, et al, 2019), among others. This kind of proof is likewise required for CDSS devices explicit to breast malignant growth treatment decision making. The authors audit returned 17 papers on CDSSs which support decision-production in breast cancer treatment. While the quantity of CDSSs carried out explicitly for breast cancer is restricted, the review showed that there are various sorts of treatment decisions that can be upheld by CDSSs with respect to, medical procedure, chemotherapy, hormonotherapy, radiotherapy, and follow-up.

Regarding the second question of the study, specifically to get the benefits and detriments of CDSS use, the authors observed that current CDSSs might actually further develop services within the medical services framework, time used to decision making, and wellbeing related personal satisfaction for patients; and decrease both medical services expenses and clinical mistake rates (Bright, et al, 2012; Jia, et al, 2016). Nonetheless, just like any medical care development, CDSSs ought to be thoroughly surveyed before spread into clinical practice, i.e., validate that for sure it gets to the next level with clinical care or patient results. Furthermore, a few controlled preliminaries are justified (Kawamoto, and Lobach, 2003). Clinical blunders are both expensive and hurtful (Jao and Hier, 2010). An error in breast malignant growth treatment decisions can have horrendous ramifications for wellbeing related personal satisfaction and result. An audit concentrate on CDSS

somewhere in the range of 1990 and 2007 observed that CDSSs could assume a critical part in helping medical services frameworks and doctors' performance.

It is essential to feature how CDSSs could change the impact on decision results, particularly for therapy decision for breast cancer patients. A development before-after study on the utilization of one CDSS, OncoDoc (Séroussi, and Bouaud, 2003) which took a gander at 127 treatment cases observed that the utilization of OncoDoc expanded consistence with clinical practice rules from 61% to 77%. The authors inferred that first and last treatment decisions were not indistinguishable in 31% of the cases (39/127). Among the 16 cases where doctors' underlying decision was not consistent by any means with OncoDoc's suggestions, doctors adjusted their perspective to agree with OncoDoc in 62% of the cases (10/16). Nonetheless, in six cases, despite the fact that they changed their decision, they remained in defiance with OncoDoc.

This study (Mazo et al, 2020) was planned to recognize, and thoroughly analyze the CDSS instruments accessible to help breast cancer treatment decisions. Thusly, the authors desire to feature the worth and clinical practice limits of the devices that are at present accessible and illuminate regions for development for future advancements in this region. Breast malignant growth treatment was picked as an area for thought because of the perplexing heterogeneity of the infection and ensuing trouble in settling on treatment decisions. In this manner, CDSSs can essentially add to this area.

It was necessary to study the literature reviews (Mazo) related to the use of (CDSS) with breast cancer, which indicate the intervention of the clinical decision support system in predicting survival in patients who have finished treatment, by entering to (CDSS) information about the age and characteristics of the selected tumor - Tumor size and grade, number of positive auxiliary nodes, and hormone receptor status in order to examine the types of treatment the patient received for the characteristics of the disease available to her. Examples of such smart tools associated with the

Clinical Decision Support System are PREDICT, DESIREE, Cancer Math, CTS5 Calculator, and other tools (CDSS), which is responsible for evaluating the treatment given to patients after it has been completed, to predict its quality only.

Here lies the point of difference between the tools (CDSS ) mentioned in the reference and our clinical decision support system. In this research, as our system developed by us is linked to the patient's file from the beginning of the diagnosis until the end of treatment, which helps the doctor at the point of care (oncology clinic, daily care department For patients with tumors, the Department of Oncology, and the Mammogram Unit) in diagnosing and treating the patient and following up on the administration of chemotherapy protocols, as our system (CDSS) is integrated with the health information system and is not just a prediction tool.

## **2.3 Background**

### **2.3.1. Breast Cancer**

Breast cancer is the most well-known reason for disease in women and the second most normal reason for malignant growth death in ladies in the U.S. Breast cancer alludes to tumors starting from breast tissue, most generally from the internal coating of milk ducts or the lobules that supply the ducts with milk.

Around the world, breast cancer involves 10.4% of all disease occurrences among women, making it the second most regular sort of non-skin disease (after a cellular breakdown in the lungs) and the fifth most basic reason for cancer death. In 2004, breast cancer caused 519,000 deaths worldwide (7% of disease deaths; practically 1% of all deaths). Bosom cancer is around 100 times more common in women than men, even though guys generally have less promising results because of poor diagnosis.

Malignancy cells are the same as the organism's cells from which they began and have comparative (yet not indistinguishable) DNA and RNA. This is why they are not all the time identified by the immune system, specifically if it is weakened (Cancer Info Guide, 2009).

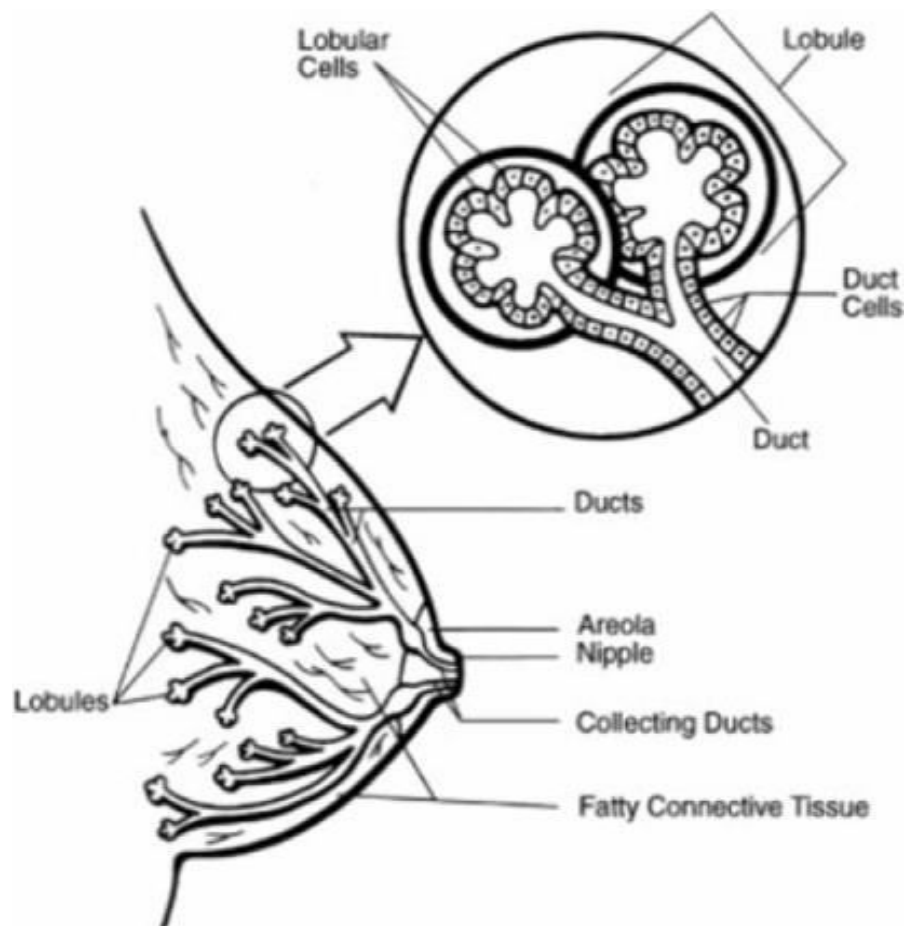
Malignant growth cells are formed from normal cells because of an adjustment/change of DNA and/or RNA. These changes/transformations can happen immediately (Law of Thermodynamics - increment of entropy), or different factors might incite them. For example, atomic radiation, electromagnetic radiation (microwaves, X-beams, Gamma-beams, Ultraviolet-beams and so on), infections, microorganisms (viruses, bacteria, fungi), parasites (because of tissue aggravation/bothering, heat, synthetic compounds noticeable all around, water and food, mechanical cell-level injury, free radicals, evolution and aging of DNA and RNA, and so forth. All these can cause mutations that can start cancer. Cancer can be called "Entropic Disease" since it is related to the expansion of entropy of the organism to where the organism cannot correct this itself. External intercession is needed to permit the organism to get back to a stable entropic state (Mieszkowski, 2006).

Malignancy develops if the immune system is not working as expected and/or the measure of cells delivered is excessively extraordinary for the immune system to eliminate. The pace of DNA and RNA changes can be too high under certain conditions, for example, undesirable environment (because of radiation, synthetic compounds, etc.) (Helmberg, 2010), poor eating routine (unfortunate cell environment) (Cancer org, 2009), individuals with hereditary inclinations to mutations (New SEER, 2007) and individuals of older age (above 80 ) (Ershler, 2005).

Normally, cancer is named after the body part in which it began; hence, breast cancer alludes to the fast development and expansion of cells in the breast tissue (Khuwaia, 2004). The breast comprises two fundamental tissues, i.e., glandular tissues and stromal (supporting) tissues. Glandular tissues house the milk-delivering organs (lobules) and the ducts (the milk passages), while stromal tissues

incorporate greasy and fibrous connective tissues of the breast (Figure 2.1). The breast is additionally comprised of lymphatic tissue-immune framework tissue that eliminates cell liquids and waste (Dig for The Cure, 2010).

There are a few kinds of tumors that may develop within various spaces of the breast. Most tumors result from benign (non-destructive) changes within the breast. For instance, fibrocystic change is a non-dangerous condition in which women develop cysts (gathered liquid), fibrosis (development of scar-like connective tissue), lumpiness, and spaces of thickening, delicacy, or breast pain (Breast Health, 2008). Most breast cancers start in the cells that line the ducts (ductal cancers). Some start in the cells that line the lobules (lobular malignancies), while a small number begins in the other tissues (Cancer org/ACS, 2009), as shown in Figure (2.1).



Figure(2.1:) Structure of breast (Sharma, et al., 2010)

## **2.3.2 Kinds Of Breast Cancer**

### **2.3.2.1 According To Site**

#### **2.3.2.1.1 Non-Invasive Breast Cancer:**

Cells that are kept to the ducts and do not attack encompassing greasy and connective tissues of the breast. Ductal carcinoma in situ (DCIS) is the most widely recognized type of non-intrusive breast malignancy (90%). Lobular carcinoma in situ (LCIS) is more uncommon and considered a marker for expanded breast cancer hazard.

#### **2.3.2.1.2 Invasive Breast Cancer:**

Cells that get through the duct and lobular divider and attack the encompassing greasy and connective tissues of the breast. Cancer can be intrusive without being metastatic (spreading) to the lymph hubs or other organs (Merck, 2008).

#### **2.3.2.2 .Frequently Occurring Breast Cancer:**

Lobular carcinoma in situ (LCIS, lobular neoplasia): The expression, "in situ," alludes to breast cancer that has not spread past the space where it at first created. LCIS is a sharp expansion in the number of cells inside the milk organs (lobules) of the breast.

Ductal carcinoma in situ (DCIS): DCIS, the most well-known kind of non-invasive breast malignancy, is restricted to the ducts of the breast. For instance, ductal comedo carcinoma (central necrosis of cancer cells within ducts), as shown in Figure (2.2).

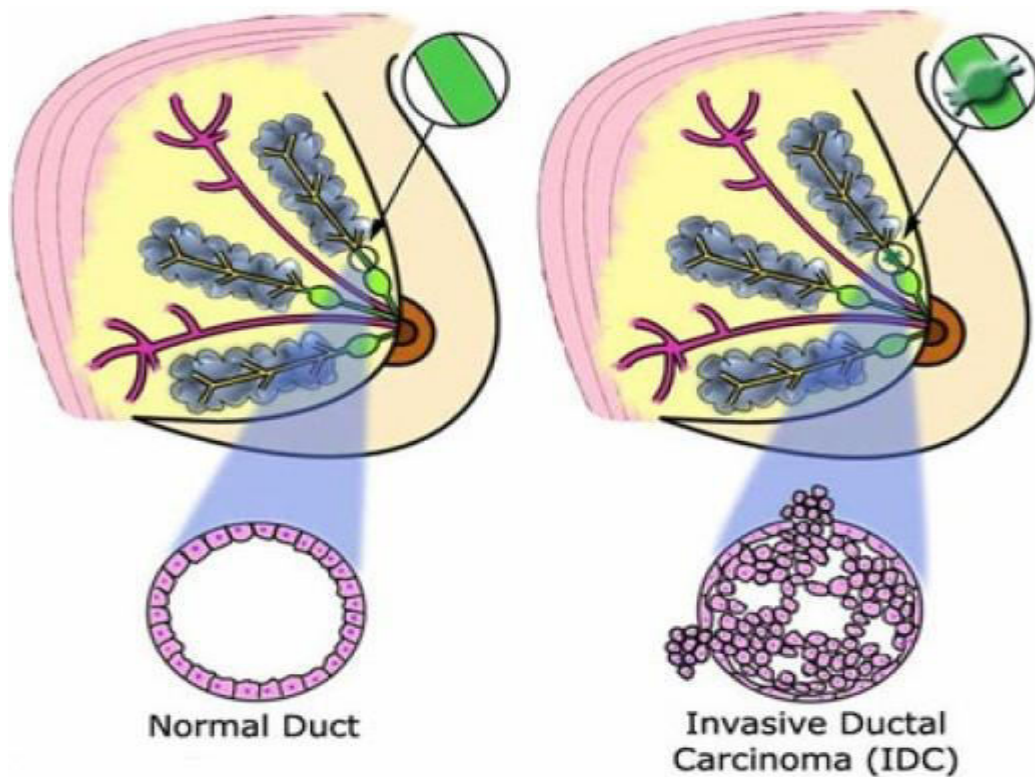


Figure (2.2): Typical Structure associated with ductal carcinoma (Sharma, et al., 2010).

#### 2.3.2.2.1 Infiltrating Lobular Carcinoma (ILC):

ILC is otherwise called invasive lobular carcinoma. ILC starts in the milk organs (lobules) of the breast, yet regularly spreads (metastasizes) to different areas of the body. ILC represents 10% to 15% of breast cancers.

#### 2.3.2.2.2 Infiltrating Ductal Carcinoma (IDC):

IDC is otherwise called invasive ductal carcinoma (IDC), starts in the milk ducts of the breast and enters the mass of the duct, attacking the greasy tissue of the breast and perhaps different areas of the body. IDC is the most well-known malignant breast growth, representing 80% of breast cancer diagnoses (Abviva, 2009).

### **2.3.2.3 Less Normally Happening Breast Malignant Growth**

#### **2.3.2.3.1 Modularly Carcinoma:**

Modularly carcinoma is an intrusive breast malignant growth that shapes a particular boundary between tumor tissue and ordinary tissue. Just 5% of breast tumors are modular carcinoma.

#### **2.3.2.3.2 Mutinous Carcinoma:**

Also called colloid carcinoma, mutinous carcinoma is an uncommon breast malignant growth formed by the mucus delivering cancer cells. Ladies with mutinous carcinoma by and large have a preferable prognosis over ladies with more normal sorts of invasive carcinoma.

#### **2.3.2.3.3 Cylindrical Carcinoma:**

Tubular carcinomas are an extraordinary sort of invading (obtrusive) breast carcinoma. Women with cylindrical carcinoma, by and large, have a preferable prognosis over ladies with more normal sorts of obtrusive carcinoma. Cylindrical carcinomas represent around 2% of breast malignancy diagnoses.

### **2.3.2.4 Inflammatory Breast Malignant Growth**

Inflammatory breast cancer is the presence of inflamed breasts (red and warm) with dimples. Additionally, thick edges are brought about by cancer cells hindering lymph vessels or directed in the skin over the breast. Even though inflammatory malignancy is uncommon (representing just 1% of breast tumors), it quickly develops.

### **2.3.2.5 Paget's Illness Of The Nipple**

An uncommon type of breast cancer growth that starts in the milk ducts and spreads to the skin of the nipple and areola. Paget's illness of the areola just records about 1% of breast cancers.

### **2.3.2.6 Phyllodes Tumor**

Phyllodes tumors can be either benign (non-cancerous) or malignant (cancerous). Phyllodes tumors develop in the connective tissues of the breast and might be treated by careful surgery. Phyllodes tumors are uncommon; under 10 women die of this kind of breast disease every year in the United States (Stephan, 2008).

### **2.3.3 Causes Of Breast Cancer**

A woman who has had breast cancer has an expanded danger of getting breast cancer in the other breast (Hartmann, et al., 2005).

#### **2.3.3.1 Critical Family History**

If a few individuals from the patient's family have had specific kinds of cancer, **the** patient may have an expanded danger of getting breast cancer (Hartmann, et al., 2005).

#### **2.3.3.2 Hereditary Causes**

Family history has been known to be a danger factor for breast cancer. Both maternal and fatherly family members are significant. The danger is most elevated if the influenced relative developed breast malignancy at a young age had cancer in both breasts or if she is a nearby family member. First-degree family members (mother, sister, daughter) are generally significant in assessing hazards. A few second-degree family members (grandmother, aunt) with breast cancer may likewise expand hazard. Breast malignant growth in a male expands the danger for all his nearby female family members. BRCA1 and BRCA2 are unusual genes that, when acquired, uniquely increment the danger of malignant breast growth to a lifetime hazard assessed somewhere in the range of 40% and 85%. Ladies who have the BRCA1 gene will generally get breast cancer at an early age (E Medicine Health, 2010).

### **2.3.3.3 Hormonal Causes**

Differences in hormonal levels may hasten breast cancer. It very well may start at the beginning and halting of periods (Menstrual Cycle), Pregnancy at an early age, Hormonal substitution treatment, Use of oral pills, etc. (Fletcher, 2008).

### **2.3.3.4 Way Of Life And Dietary Reason**

Inactive way of life, high dietary intake of fat especially in postmenopausal ladies may cause breast cancer. The utilization of alcohol is additionally another reason for breast malignancy. The danger increments with the measure of alcohol burned through. Women who burn through two to five alcoholic beverages each day have danger around one and a half times that of nondrinkers for the advancement of breast cancer (Cancerhelp, 2008).

### **2.3.3.5 Environmental Reason**

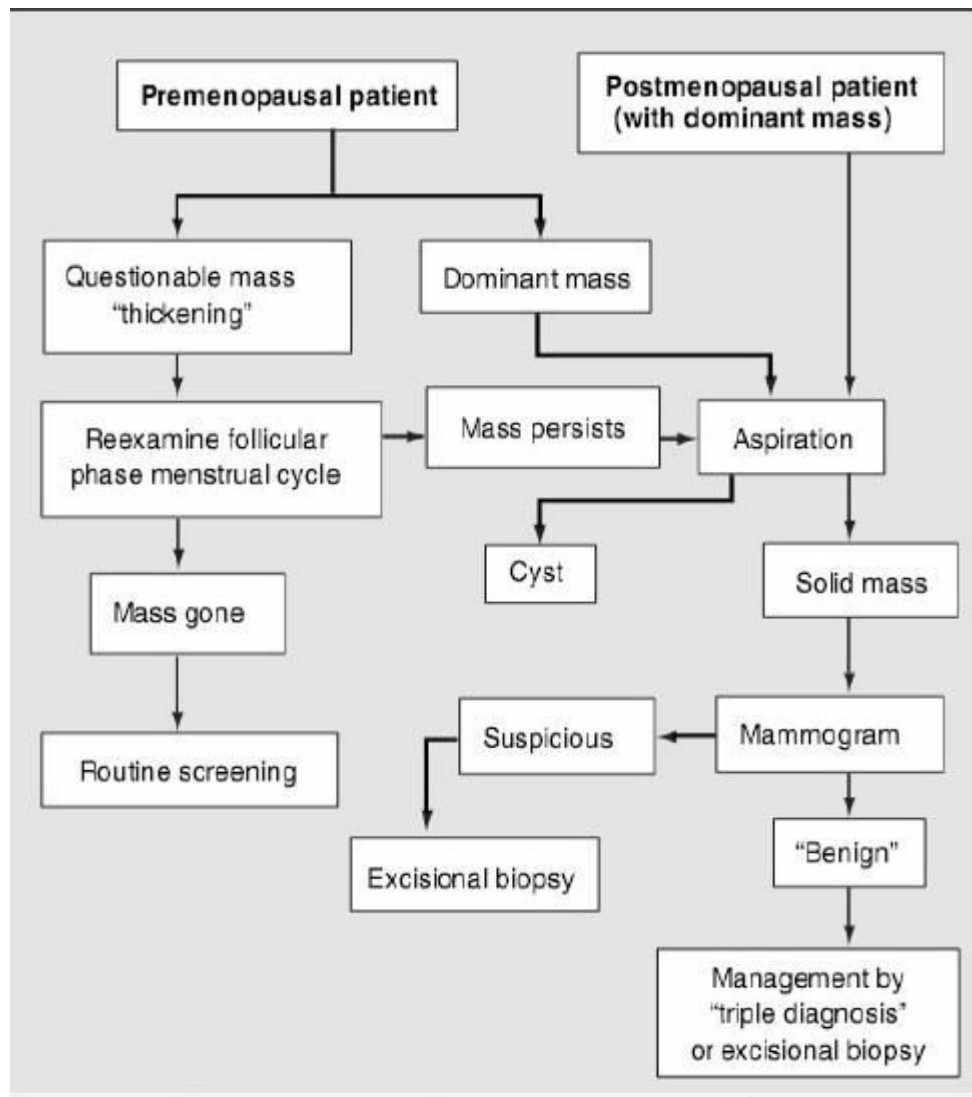
It is documented that a slight expansion in hazard in women who work with low dosages of radiation throughout an extensive period, for instance, X-ray technicians (Cancerhelp, 2008).

### **2.3.4 Sign And Symptoms Of Breast Cancer**

A good indication for breast malignancy is a lump found in the breast or armpit. Doing month to month breast self-test (BSE) is an extraordinary method to be acquainted with the breasts' surface, repetitive changes, size, and skin condition. The overall alarming highlights of breast malignancy are expanding or lump (mass) in the breast, swelling in the armpit (lymph hubs), nipple release (clear or bloody), pain in the areola, retracted nipple, textured or pitted skin on nipple, relentless delicacy of the breast, and uncommon breast agony or distress. In the Advanced stage (Metastatic) of illness, underarm lymph nodes are available with different manifestations like bone agony (bone metastases), shortage of breath (lung metastases), drop-in craving (liver metastases), accidental weight reduction (liver metastases), migraines, neurological torment or weakness (Stephan, 2007).

### 2.3.5 Screening/Diagnosis Of Breast Cancer

Breast cancer is usually diagnosed by biopsy of nodule detected by mammogram or by palpation (Smith, 2008), as shown in Figure (2.3).



Figure(2.3) Various approaches for diagnosis of breast cancer (Lippman, 2008)

### 2.3.6 Stages Of Breast Cancer:

When cancer is diagnosed, a stage is assigned to it, based on how advanced it is. The stage helps doctors determine the most appropriate treatment and the prognosis. Stages of breast cancer may be described generally as in situ (not invasive) or invasive. Stages may be described in detail (Table 2.1) and designated by a number (0 through IV).

Stage	Description
<b>In situ carcinoma</b>	
0	The tumor is confined, usually to a milk duct or milk-producing gland, and has not invaded surrounding breast tissue.
<b>Localized and regional invasive cancer</b>	
I	The tumor is less than ¾ inch (2 centimeters) in diameter and has not spread beyond the breast.
IIA	The tumor is ¾ inch or less in diameter and it has spread to one to three lymph nodes in the armpit, microscopic amounts have spread to lymph nodes near the breastbone on the same side as the tumor, or both <i>or</i> The tumor is larger than ¾ inch but smaller than 2 inches (5 centimeters) in diameter but has not spread beyond the breast.
IIB	The tumor is larger than ¾ inch but smaller than 2 inches in diameter, and it has spread to one to three lymph nodes in the armpit, microscopic amounts have spread to lymph nodes near the breastbone on the same side as the tumor, or both <i>or</i> The tumor is larger than 2 inches in diameter but has not spread beyond the breast.
IIIA	The tumor is 2 inches or less in diameter and has spread to four to nine lymph nodes in the armpit or has enlarged at least one lymph node near the breastbone on the same side as the tumor <i>or</i> The tumor is larger than 2 inches in diameter and has spread to up to nine lymph nodes in the armpit or to lymph nodes near the breastbone.
IIIB	The tumor has spread to the chest wall or skin or has caused breast inflammation (inflammatory breast cancer).
IIIC	The tumor can be any size plus at least one of the following: It has spread to 10 or more lymph nodes in the armpit. It has spread to lymph nodes under or above the collar bone. It has spread to lymph nodes in the armpit and has enlarged at least one lymph node near the breastbone on the same side as the tumor. It has spread to four or more lymph nodes in the armpit, and microscopic amounts have spread to lymph nodes near the breastbone on the same side as the tumor.
<b>Metastatic cancer</b>	
IV	The tumor, regardless of size, has spread to distant organs or tissues, such as the lungs or bones, or to lymph nodes distant from the breast.

Table(2.1): Stages of breast cancer(Breast Cancer org, 2010)

### 2.3.7 Management Of Breast Cancer (Sharma, et al., 2010)

1. Surgery
2. Radiation therapy
3. Chemotherapy
4. Hormone therapy
5. Ontogenesis Inactivation

6. Augmentation of Tumor Suppressor Genes
7. Cell-Target Suicide
8. Chemo protection Approach
9. Virus-mediated enclitic
10. Immunomodulation

## **2.4 Clinical Decision Support System (CDSS)**

Computer-based CDSSs can be tracked down to the 1970s. At that point, they had helpless framework coordination, were time exhaustive, and were regularly restricted to scholastic pursuits (De Dombal, 1992; Shortliffe and Buchanan, 1975). Likewise, moral and lawful issues were raised around the utilization of computers in medication, doctor self-governance, and who might be to blame when utilizing the proposal of a framework with defective explain ability (Middleton et al., 2016). As of now, CDSS frequently utilize web applications or incorporation with electronic health records (EHR) and computerized provider order entry (CPOE) frameworks. They can be controlled through desktops, tablets, and cell phones, yet different tools such as biometric monitoring and wearable health innovation. These devices might create outputs directly on the device or be connected to EHR databases (Dias, 2018).

Technological progression, lately, has assumed a vital part in helping medical care associations in all directions. Information investigation, usage of information, and cloud computing have assumed a fundamental part in progressing and combination of Clinical Decision Support Systems (CDSS) (Sulley, 2018). The utilization of these instruments is pointed toward helping associations to acquire the advantage in improving care quality just as using cost-saving methodologies in care services. Decision Support Systems as an instrument has been exceptionally useful in helping associations to acquire a superior comprehension of explicit patterns and elements identifying with ailments. This important device has been used infeasible applications for improving care just as absorbing changes in the medical services field. Patient data or information assortment is an issue of past years; the

principle obstruction lately has the essential instruments to assess accessible information (Makary and Daniel, 2016).

The usage of wellbeing data exchanges and the production of administration guidelines can help health associations in improving care quality. Quality care arrangement has been ruined in numerous networks across the United States for some reasons; these incorporate inefficiency, monetary limitations, lack of research, and absence of dynamic patient support or commitment to care. New studies showed a developing pattern in the use of CDSS in the journey of improving different areas of care delivery. In the campaign of comprehension of the effect of biomedical informatics and CDSS on medical care frameworks, one needs to consider different fields like statistics about the population, finance, guidelines, strategies, and governmental issues among numerous others (USFDA, 2017).

Clinical Decision Support Systems (CDSS) is an instrument intended to help physicians in medical care decision-making cycles (Murphy, 2014). It has been an essential apparatus in clinical settings throughout the long term. It assumes a fundamental part in a clinical environment, from sickness avoidance to drug interactions. Changes in medical services law, just as the need to improve quality of care, have been the consolation of insemination of CDSS within medical services associations (Sulley, 2018).

Computerized clinical decision support systems, or CDSS, address a change in perspective in medical care today. CDSS are utilized to expand clinicians in their unpredictable decision-making cycles. Since their first use during the 1980s, CDSS has quickly developed. They are presently regularly managed through electronic clinical records and other computerized clinical work processes, which has been worked with by expanding worldwide reception of electronic clinical records with cutting edge abilities. Despite these advances, there remain questions concerning the impact CDSS have on the suppliers who use them, patient results, and expenses. There have been

various published models in the past decade(s) of CDSS examples of overcoming adversity in the past decade, yet significant mishaps have shown us that CDSS is not without risks.

## **2.5 Functions and Advantages of CDSS**

### **2.5.1 Hospitals and Healthcare Organizations**

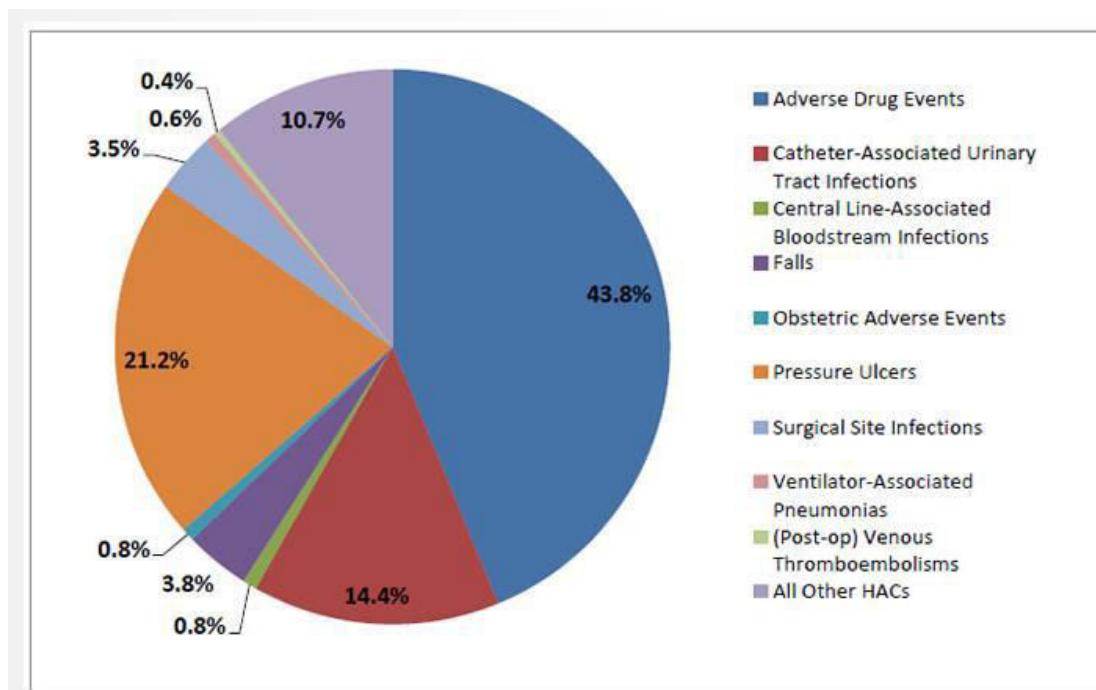
Rapid changes in medical care conveyance elements, just as the galactic expense related to care, are at a point never seen before. Although these elements are highly convoluted, there are devices accessible for investigating tending to the issues confronting medical care conveyance today. The capacity to quickly break down organized and unorganized informational collection improves patient care and makes tremendous clinical importance to patients (HBR.org, 2013). Such discoveries support the idea of effective information management and positive results in medical services conveyances. Information analytics have made it workable for medical care suppliers, epidemiologists, and infectious disease experts to acquire reliable data in warding off common issues before they cause complex issues.

### **2.5.2 Medication**

A study in the Journal of Patient safety assessed that the number of people who endure some preventable mischief is between 210,000 to 400,000 every year (Gilroy, 2013). Of these cases, the dominant parts were about medications and contraindications, which appeared as the significant justification for inpatient death (Allen and Pierce, 2016). CDSS assumes an extensive part whenever instilled satisfactorily into the care interaction, as exhibited by numerous researchers (USFDA, 2017). CDSS could fill in as warning systems when there are contraindications and any medication reactions, as seen with numerous reports published by the FDA. Such plans will urge the administrators of prescriptions to be more thoughtful in executing their obligations.

CDSS helps in the prevention measures presentation like thromboembolism over the study time frame (Murphy, 2014); the above assertion further supports that CDSS emphatically affects

different spaces of care arrangement. Decision support networks help in diagnosis and services and solid warning instruments to help suppliers remember principles on all levels of the care measures. The results of such investigation have been demonstrated to be essential in assorted spaces of care arrangement. For example, wellbeing monitoring arrangements of current data on patient physiological signs have changed how to deal with heart care; research by Castellano et al. (2015). Demonstrates how pragmatic such a methodology is in heart care. Such apparatuses have supported breaking down and acquiring a superior comprehension of patient necessities and thus fitting the clinical arrangement. In the current environment, using DSS from various sources and understanding local, provincial, and public patterns would advance our way of dealing with care. The following portrays the predominance of blunders in medical services and socioeconomics (Figure 4).



Figure(2.4): Source AHRQ National Scorecard Estimates from Medicare Patient Safety Monitoring System, National Healthcare Safety Network, and Healthcare Cost and Utilization Project.

### 2.5.3 Administrative

The McKinsey Global Institute assessed that surplus spending on wellbeing administration and insurance represented as much as 21% of the assessed absolute surplus spending (\$477 billion in 2003). Presented that 21% of surplus spending on administration would add up to about \$120 billion in 2006 and about \$150 billion in 2008 (Reinhardt, 2008). The above assertion sums up the effect of this field during the time for care. The explanation that numerous medical care offices need much regulatory staff could be answered when investigating insurance strategies and prerequisites. An investigation directed by the Centers for Medicare and Medicaid discovered that an expected 14 percent of medical services consumptions goes toward managerial expenses (Yong and Saunders, 2010; Reinhardt, 2008). Analytic devices are accessible in supporting medical services association cut cost and make compelling components for charging and insurance information assortment. In addition, these devices could help with building up a level stage at reasonable costs for purchasers and better shopper knowledge for insurance agencies. A reasonable comprehension of information and its practical use would be significant, intending to numerous issues experienced in medical services from the administration perspective. There is a broad regulatory part in the health area that is urgent for viable administration of medical services offices.

Patients experience managerial staff from the hour of admission to discharge. Errors in the emergency stage and initial presentation could significantly influence the methodology and way of treatment. Moreover, it impacts the financial part of the cost and turns into a load to patients and medical services offices. Decision frameworks execution within these offices could wipe out such issues. Such frameworks would guarantee the appropriate patient record is kept up by a double interaction where patients and managerial staff input data into an EHR framework. The CDSS framework would then help check and get disparities or confusion between these entries. As referenced, such an apparatus would help wipe out medication blunders and procedural organization. The components that influence the higher managerial expenses are assorted, and CDSS will help

cover a portion of the issue relating to the progressively significant expense (Yang and Grissinger, 2013).

### **2.5.4 Population Health**

The United States has been spending progressively more on medical services than expected throughout the long term. This among numerous different variables is straightforwardly reassuring more people and partners to assess the effect enormous information could have on discovering approaches to address populace health. "Enormous information or big data" uses data given by patients themselves; this engages people in adopting dynamic parts in care strategies. For instance, information utilized by big data could help people tailor diet, work out, and other way of life changes; medical services has generally been followed through on a one-on-one way to deal with chronic illness management (Egger, et al., 2015). These points would guide all suppliers focusing on a specific patient; organize their technique and henceforth better result of individualized care and everyone in general. Such insights and data have been demonstrated to help assess everyone on tailoring wellbeing procedures.

Greenville Health System carried out a program to screen and help in controlling medical hospital procured infections; the study gave data that was superior to different methods for estimation used at their facilities previously. The use of such tools in different spaces of populace wellbeing has been demonstrated to be indispensable intending to medical hospital issues like obtained infections or conditions. Devices like Collaborative Assessments and Recommendation Engine (CARE) created by a scientist at the University of Notre Dame that assess patients' resemblances and make risk ideas for supplier assessments could be used as an early identification apparatus for explicit illnesses and clinical presentation. This prescient symptomatic methodology gives data expeditiously to partners and people to dispense assets and make changes or look for consultations to address emerging issues. Huang et al. (2015) published a local area-based infectious disease study in China; the study searched for individual variables influencing the predominance of hepatitis. The result of the study

can give one a viewpoint on how big data can have a gigantic part in making such examinations well organized.

Life expectancy has been expanding throughout the long term; numerous elements include progressed well-being approaches and medical technologies. As the elderly populace in the United States grows the requirement for critical medical care conveyance to people over 65 years of age. This age group, without a doubt, spends more on medical services than some other, and this is probably going to proceed; the absence of comprehension for aged care is fundamental for the long-term reasonability of the sector (Johnston and Hume, 2015). Data investigation furnishes us with crucial data on fitting and distributing assets to explicit regions where these populaces would require those most. This would take considerable strides during the time spent diagnosis and care provision; moreover, it would help improve the quality of care given to this populace.

### **2.5.5 Preventive Medicine**

Information has helped numerous association predicts explicit elements dependent on a few factors; this has then helped with planning and improvement of viable methodologies for battling illnesses or outbreaks. For instance, the making of a module that guides in discovering different elements related to disease has been demonstrated to help aid solution discovering measures. An obvious sign of such application is for the situation and way to deal with handling epidemics like Ebola (Rossi, 2015). Just as this model helped in acquiring a superior comprehension of the expected methods of the spread of sickness, the reasonable procedures of ending and planning could be made from such data. In the outbreak of Ebola in West Africa, influenced countries were not prepared for the quick spread; they, additionally, did not have satisfactory assets or better comprehension of the infection. Every one of these fundamental data might have changed the elements we see today in WestAfrica and different parts concerning Ebola and other ailments.

A new study published by Ram et al. (2015) on foreseeing asthma-related crisis affirmations further helps the effect big data can have on examining illness direction. One can see the immediate impact of social media on comprehension and get ready for clinical introductions in the medical care framework. A newly published paper by Olsen et al. (2015) used a pediatric health information database (PHIS) as a method for acquiring data in fitting observation for movement-related infectious illnesses; the PHIS information base offered a few strengths and reconnaissance apparatuses that created significant outcomes for understanding pediatric wellbeing attributes. These models further fill in as verification of the adequacy of information and CDSS or biomedical informatics in coordinating and contriving protocols for explicit clinical issues.

There have been huge medical services assets contributions to wellbeing data frameworks including CDSS. The result of this literature review will probably show a positive or negative pattern dependent on specific methodologies taken by researchers in carrying out and use of CDSS. Acquiring an intensive comprehension of pragmatic, reasonable execution and result approaches would prepare for diminishing medical care costs and improving health care quality. Besides, this exploration has the capability of featuring different positives and negatives about embracing and carrying out one CDSS contrasted with another. As the expense of care expansions in the United States so will trouble to get to affordable medical care for a critical piece of the populace. The usage of a clinical decision support system (CDSS) as a component of electronic wellbeing systems is basic in accomplishing the objective of arriving at the patient and giving quality care. Moreover, such systems would help in improving results and simplicity of exploration for nonstop improvement in the ways to deal with care as demonstrated by numerous studies. Another basic part of medical care in the world is the rising administrative expense that directly or indirectly influences patients' affordability. CDSS could help in wiping out a portion of these expenses just as forestall administrative mistakes within the framework of the medical service.

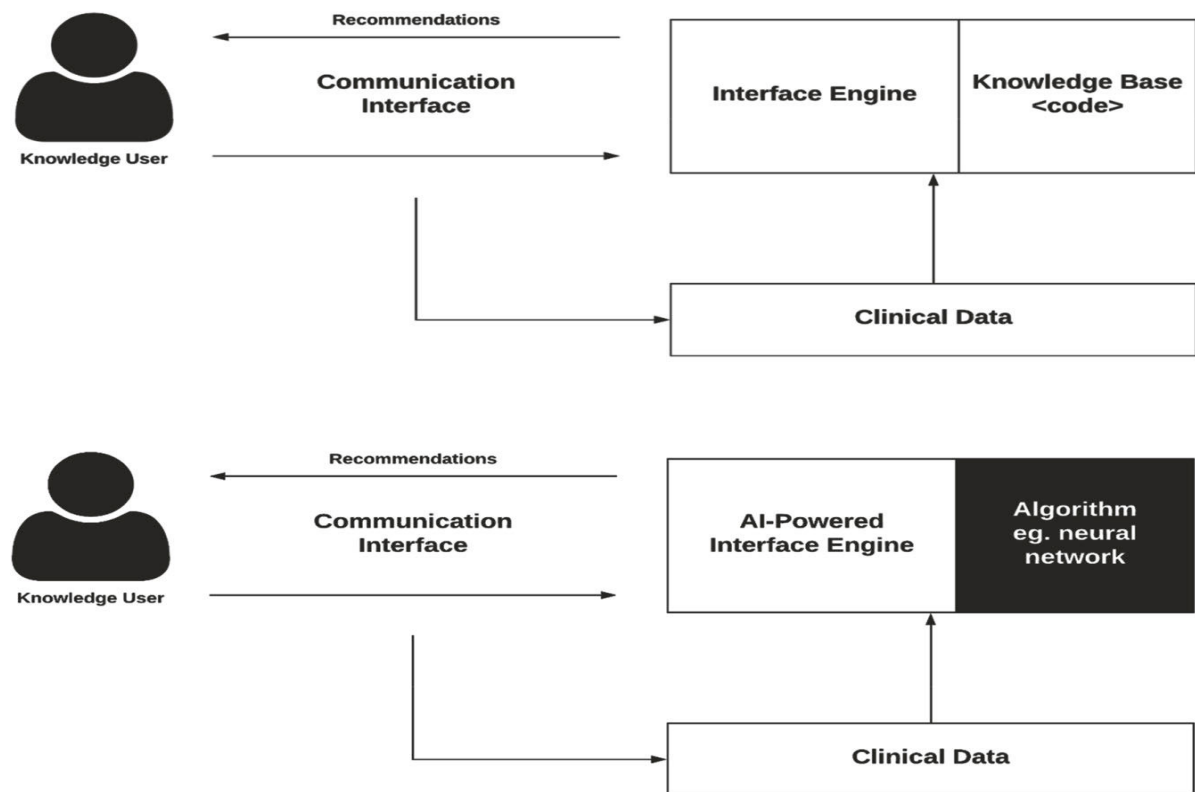
Substantial medical services assets contribute to well-being data frameworks, including CDSS. The result of this literature review will probably show a positive or negative pattern dependent on specific methodologies taken by researchers in carrying out and use of CDSS. Acquiring an intensive comprehension of pragmatic, reasonable execution and result approaches would prepare to diminish medical care costs and improve health care quality. Besides, this exploration can feature different positives and negatives about embracing and carrying out one CDSS contrasted with another. For example, the expense of care expansions in the United States will trouble to get affordable medical care for a critical piece of the populace.

On the other hand, using a clinical decision support system (CDSS) as a component of electronic well-being systems is essential in arriving at patients and giving quality care. Moreover, such systems would help improve results and simplicity of exploration for continuous improvement in dealing with care, as demonstrated by numerous studies. Another essential part of medical care globally is the rising administrative expense that directly or indirectly influences patients' affordability. CDSS could help wipe out a portion of these expenses, just as forestall administrative mistakes within the framework of the medical service.

Healthcare conveyance keeps on changing depending on the situation based on a few variables including legislation, technological improvements, and changes in medical convention among numerous others. Biomedical informatics is at the front line of these changes; it is basic for all parts of the medical care industry to sufficiently comprehend the capability of this significant resource. Biomedical informatics with the teaching of CDSS furnishes wellbeing experts with an important asset in concentrating all parts of medical services; it additionally offers numerous answers applicable to tending to issues like outbreaks and socioeconomics. Besides, CDSS fills in as dependable methods controlling administration, prescription, and management exercises. The fundamental issue or worry of numerous partners concerning CDSS is doctor or supplier input; the

legitimate use and teaching of significant information guide suppliers to settle on a superior decision as demonstrated in numerous investigations referenced previously.

There is a requirement for medical care associations' ongoing discussion and public education on how informatics and devices could change care systems. Besides, a careful clarification and affirmation of the security of patient data should be made to acquire public trust on this issue. From the review of different publications and researches, it is apparent that there is the dynamic use of biomedical informatics and CDSS in medical services. As referenced above, the elements and ways to deal with care are developing; the way the medical care associations use data accessible to them will have a critical impact on what the eventual fate of medical services will resemble. It is in this manner basic for us to put resources into proceeding with education in biomedical informatics to improve all parts of care conveyance. As shown in figure (2.5)



**Figure (2.5):** key associations in knowledge-based and non-knowledge based CDSS

They are made out of (1) base: the principles that are customized into the framework (knowledge-based), the algorithm used to display the decision (non-knowledge based), just as the information accessible, (2) inference engine: takes the customized or AI-decided principles, and information structures, and applies them to the patient's clinical information to create a yield or activity, which is introduced to the end-user (eg. doctor) through the (3) communication mechanism: the website, application, or EHR frontend interface, with which the end client collaborates with the system (Yong and Saunders, 2010).

### 2.5.6 Patient Safety

CDSS likewise improves patient security through updated frameworks for other clinical occasions, and not simply those that are prescription-related. For example, among various models, a CDSS for blood glucose estimation in the ICU had the option to diminish the number of hypoglycemia events (Eslami, 2012). This CDSS naturally incited medical nurses to take a glucose estimation as indicated by nearby glucose checking convention Techniques to decrease medicine mistakes generally utilize CDSS. Mistakes, including drug-drug interactions (DDI), are usual and preventable, with up to 65% of inpatients being presented to at least one possibly unsafe mixes (Vonbach et al., 2008). Computerized Provider Order Entry (CPOE) frameworks are currently planned with drug security programming with shields for dosing, duplication of treatments, and DDI checking (Helmons et al., 2015). The sorts of alarms created by these frameworks are among the most scattered sort of decision support (Koutkias and Bouaud, 2018). However, researchers have tracked down a significant degree of changeability between how cautions for DDIs are shown (e.g., passive or active/problematic), which are prioritized (Cornu et al., 2018), and in the calculations used to recognize DDIs (McEvoy,2017). Systems frequently have fluctuating levels of unessential cautions introduced, and there is no norm for how best to carry out which cautions to suppliers. The U.S. Office of the National Coordinator for Health Information Technology has built up a rundown of 'high-priority' rundown of DDIs for CDS, which has arrived at different degrees of endorsement and

arrangement in CDSS' of different nations, including the U.K., Belgium, and Korea (Koutkias and Bouaud, 2018; Cornu et al., 2018).

Different frameworks focusing on patient wellbeing incorporate electronic drug dispensing systems (EDDS) and barcode point-of-care (BPOC) medicine organization systems (Mahoney et al., 2007). These are frequently carried out together to make a 'closed-loop,' where each progression of the interaction (prescribing, transcribing, dispensing, administering) is computerized and happens within an associated framework. The medicine is naturally recognized at the organization through radiofrequency identification (RFID) or barcodes and cross-checked with patient data and remedies. This presents another objective for CDSS. The potential advantage is avoiding prescription organization mistakes happening at the 'bedside.' Selection is generally low, somewhat because of high technology prerequisites and costs (Peres-Lopez et al., 2011). However, research showed great adequacy for these frameworks in lessening errors (Levtzion-korach, 2010). Mohoney et al. (2007) showed that many of these frameworks could be joined with CPOE and CDSS all the time, with diminished prescribing mistake rates for drug hypersensitivity recognition, excessive dosing, and fragmented or muddled ordering. As with most CDSS, mistakes can, in any case, be made if suppliers preclude or intentionally work around the technology (Van der Veen, 2018).

CDSS likewise improves patient security through update systems for other clinical occasions, and not simply those that are prescription-related. Among various models, a CDSS for blood glucose estimation in the ICU had the option to diminish the number of hypoglycemia events (Eslami, 2012). This CDSS naturally incited medical nurses to take glucose estimation as indicated by a nearby glucose checking convention, which determined how frequently estimations ought to be done by explicit patient socioeconomics and past glucose levels/trends (Eslami, 2012). Overall, CDSS focusing on understanding wellbeing through CPOE and different frameworks have commonly been effective in decreasing prescribing and dosing mistakes, contraindications through automated

cautions, drug-occasion observing, and more (Jia, et al., 2016). Patient security can be kind of CDSS, regardless of the basic role for their execution.

### **2.5.7 Clinical Management**

Studies have shown that CDSS can expand devotion to clinical guidelines (Kwok et al., 2009). This is huge because conventional clinical rules and care pathways have been hard to execute, practically speaking with low clinician devotion. The presumption that experts will peruse, disguise, and carry out new rules has not, truthfully, been done (Shortliffe, 2006). However, the standards verifiably encoded in guidelines can be in a real sense encoded into CDSS. Such CDSS can take an assortment of structures, from normalized request sets for a focus on the case, cautions to a particular convention for the patients it relates to, updates for testing, and so forth. Moreover, CDSS can help oversee patients on research/treatment protocols, follow and set orders, and follow-up for references, just as guaranteeing deterrent care (Salem, 2018).

CDSS can likewise make clinicians aware of how to connect with patients who have not followed the management designs or are expected for follow-up, and help recognize patients qualified for research dependent on explicit criteria. A CDSS planned and carried out at Cleveland Clinic gives a state-of-care alarm to doctors when a patient's record matches clinical preliminary criteria. The alarm prompts the client to finish a form that builds up qualification and consent to contacting, advances the patient's outline to the examination organizer, and prints a clinical preliminary patient data sheet (Embi, et al., 2005).

### **2.5.8 Cost Containment**

CDSS can be cost-effective for wellbeing frameworks, through clinical interventions, diminishing inpatient length-of-stay (LOS), CPOE coordinated frameworks proposing less expensive prescription alternatives (Calloway, et al., 2013), or then again diminishing test duplication. A CPOE-rule was executed in a pediatric cardiovascular intensive care unit (ICU) that restricted the booking of blood count, chemistry, and coagulation control boards to a 24-h interval (Algaze, 2016). This diminished

laboratory assets usage with extended expense savings funds of \$717,538 each year, without expanding LOS, or mortality. CDSS can inform the client of less expensive options in contrast to medications, or conditions that insurance agencies will cover. In Germany, numerous inpatients are changed to drugs on medical clinic drug models. In the wake of tracking down that 1 of every 5 replacements was wrong, Heidelberg emergency hospital developed a medication switch algorithm and incorporated it into their current CPOE system (Pruszydlo, 2012). The CDSS could switch 91.6% of 202 medicine consultations automatically, without any mistakes, expanding wellbeing, lessening responsibility, and decreasing expense for suppliers.

### **2.5.9 Administrative Functions**

CDSS offer help for clinical and symptomatic coding, requesting strategies and tests, and patient emergency. Planned algorithms can propose a refined list of diagnostics codes to help doctors choose the most appropriate one. A CDSS was supposed to address incorrectness of ICD-9 emergency department(ED) affirmation coding (ICD is International Statistical Classification of Diseases, normalized codes used to address infections and diagnoses) (Bell et al., 2013). The apparatus utilized an anatomy graphical interface (visual, intuitive portrayal of the human body) connected to ICD codes to help ED doctors discover symptomatic confirmation codes quicker. CDSS can straightforwardly improve the quality of clinical documentation. An obstetric CDSS highlighted an upgraded provoking framework, fundamentally improving documentation of labor induction signs and assessing fetal weight, contrasted with control hospital (Haberman, 2009). Documentation accuracy is significant because it can straightforwardly help clinical protocols. For instance, a CDSS was executed to guarantee patients were appropriately immunized after splenectomy to battle the expanded danger of infections (counting pneumococcal, *Haemophilus influenzae*, meningococcal, and so on) that accompanies spleen removal. Nonetheless, the authors (McEvoy et al., 2017) tracked down that 71% of patients with the term 'splenectomy' in their EHR did not have it reported on their concern list (which triggered the

CDSS alert). A supplemental CDSS was then evolved to upgrade issue list documentation of splenectomy and improve the utility of the first immunization CDSS.

### **2.5.10 Diagnostics Support**

CDSS for clinical diagnosis is known as diagnostic decision support systems (CDSS). These frameworks have generally given an automated consultation or filtering step, whereby they may be given information/client determinations and afterward yield a list of conceivable or plausible diagnoses (Berner, 2016). Unfortunately, CDSS have not had as much impact as different sorts of CDSS (yet) for reasons including negative doctor insights and predispositions, poor accuracy (frequently because of gaps in information accessibility), and poor framework combination requiring manual information entry (Segal et al., 2017). The last is improving with better EHR incorporation and normalized vocabulary like Snomed Clinical Terms.

A genuine illustration of a successful DDSS was made by Kunhimangalam et al. (2014) to diagnose fringe neuropathy utilizing fluffy rationale. Through 24 information fields that incorporate symptoms and demonstrative test yields, they accomplished 93% precision contrasted with specialists at distinguishing motor, sensory, blended neuropathies, or ordinary cases. While this has great utility, particularly in nations with less access to well-known clinical specialists, there is also a craving for frameworks to enhance expert diagnostics. DXplain is an electronic reference-based DDSS that gives plausible diagnoses dependent on clinical manifestations. In a randomized control preliminary including 87 family medication occupants, those randomized to utilize the framework appeared fundamentally higher accuracy (84% versus 74%) on an approved diagnostic test including 30 clinical cases (Martinez-Franco, 2018).

Given the known rate of diagnostic mistakes, especially in essential care, there is a great deal of expectation for CDSS and Information Technology answers to offer enhancements to diagnosis (Singh et al., 2017). We currently see diagnostic frameworks being created with non-information-

based methods like machine learning, which may make ready for more precise diagnostics. The Babylon Artificial Intelligence fueled Triage and Diagnostic System in the U.K. is a simple illustration of the potential, yet additionally of the work that actually must be done before these frameworks are prepared for primetime (Razzaki, 2018).

#### **2.5.10.1 Diagnostics Support: Imaging**

Knowledge-based imaging CDSS are commonly utilized for image requesting. CDSS can help radiologists choose the most proper test to run, give reminders of best practice rules, or change contraindications to difference. An interventional CDS for image requesting at Virginia Mason Medical Center was appeared to significantly diminish the use pace of lumbar MRI for low back pain, head MRI for migraine, and sinus CT for sinusitis (Blackmore et al., 2019). The CDS required a series of inquiries to be replied to by suppliers before image ordering (POC) to confirm suitability. Critically, if a picture was denied, the framework recommended an option. Another marketed model is RadWise®, which guides clinicians to the most pertinent imaging requests by examining patient symptoms and coordinating them with an enormous diagnosis data set. Likewise, it gives suitable use suggestions at the place of care (DSS Inc).

There is an extraordinary premium in non-information-based CDS for improved imaging and accuracy radiology ('radionics'). With images representing expanding measures of clinical information, however requiring broad manual understanding, suppliers need innovations to help them extract, envision, and interpret (Giardino, 2017). Artificial Intelligence (AI) advances are demonstrating fit for giving bits of knowledge into information past what people can. To do as such, these advances utilize progressed pixel acknowledgment and image grouping algorithms, most noticeably: deep learning (DL). IBM Watson Health, Deep Mind, Google, and different organizations are at the front edge, creating items for tumor detection, clinical imaging interpretation, diabetic retinopathy diagnosis, Alzheimer's diagnosis through multimodal highlight learning (Suzuki and Chen, 2018), and innumerable more. IBM Watson's 'Eyes of Watson' has had

the option to join image recognition of a brain scan with text acknowledgment of case portrayals to give far-reaching decision help (or what IBM depicts as a 'psychological assistant') (IBM, 2016).

A few tasks have had the option to exhibit performance that is debatably 'comparable to' human experts. For instance, Google's group prepared a profound convolutional neural organization (CNN) to identify diabetic retinopathy (vein damage in the eye) from a dataset of 130,000 retinal pictures with a high affectability and specificity (Gulshan, 2016). The algorithm execution was on a standard with US board-certified ophthalmologists. Another study as of late published by the Stanford group exhibited a CNN for recognizing arrhythmias on the electrocardiogram that surpassed the precision (F1 and affectability with coordinated with explicitness) of the average cardiologist on all rhythm classes (Hannun, 2019). With the current pace of progress, a few specialists dubiously estimate that in 15–20 years, most symptomatic imaging translation will be done (or possibly pre-handled) by computers (Erickson, 2016). For the time being, in any case, we should consider these early frameworks an expansion or increase to a clinician's accessible toolset.

#### **2.5.10.2 Diagnostics Support: Laboratory And Pathology**

Another subset of diagnostics where CDSS can be helpful is laboratory testing and interpretation. Cautions and updates for strange laboratory results are essential and omnipresent in EHR frameworks. CDSS can likewise expand the utility of laboratory-based tests to stay away from more dangerous or more obtrusive diagnostics. In Hepatitis B and C testing, liver biopsies are viewed as the best quality level for diagnosis, while non-obtrusive lab tests are not accurate enough to be acknowledged. In any case, AI models are being built up that consolidate different tests (serum markers, imaging, and gene tests) to create a much more superior accuracy. There is an additional application for CDSS as an understanding apparatus where a test's reference ranges are exceptionally customized, for instance, age, sex, or sickness subtypes (Morkrid, 2015).

Pathology reports are essential as decision focuses for some other clinical specialists. Some CDSS can be utilized for automated tumor evaluation. This was accomplished for urinary bladder tumor evaluating and assessing recurrence, with up to 93% accuracy. The equivalent has been accomplished for brain tumor characterization and grading. There are numerous different models including computerized ECG investigation, computerized arterial blood gas understanding, protein electrophoresis reports, and CDSS for blood cell counting (Berner, 2016).

### **2.5.10.3 Patient-Confronting Decision Support**

With the 'Personal Health Record' (PHR) approach, we see CDS usefulness incorporated, like EHRs, with the patient as the end client or manager of the information. This is an incredible advance towards patient-centered care. CDS-supported PHRs are the ideal apparatus to carry out shared decision-making among patients and suppliers, explicitly because CDSS can eliminate a 'lack of data as an obstruction to a patient's interest in their care. PHRs are often planned to expand business EHR software or independent electronic or mobile-based applications. When associated with EHRs, PHRs can have a two-way relationship, whereby data entered straightforwardly by the patient can be accessible to their suppliers. Furthermore, data in the EHR can be sent to the PHR for patients to view (Davis et al., 2017).

One of the earliest PHRs, the "Patient Gateway," was a dashboard for patients to see medications and laboratories and speak with their physicians. This has extended, and a few frameworks currently permit patients to adjust their care records, affecting the EHR information (Hanauer et al., 2014). Another model is Vanderbilt University's (My Health At Vanderbilt), a PHR wholly incorporated into the institutional EHR. Additional to infection focused on conveying patient information, they joined a Flu Tool for patients with influenza-like symptoms to choose the degree of care they need and afterward helped them look for treatment. Symptom following is a valuable and expected component of PHRs, yet the assortment of the gathered information is boundless, from sensitivities to insurance coverage to remedy and medicine information (Roehrs et al., 2017).

Furthermore, PHRs and other patient monitoring applications can gather data from wellbeing tools and other suitable places to make significant bits of knowledge for suppliers. Again, a brilliant model exists in diabetes care. Numerous frameworks are now in use, yet one specifically spearheaded by the Stanford School of Medicine utilizes a wearable glucose screen that sends information to an Apple gadget (HealthKit) (Kumar et al., 2016). Apple has made Health Kit harmonious with the Epic EHR and Epic PHR, "MyChart." This effectively permits suppliers to screen glucose patterns in their patient's in-between visits and contact them through MyChart for follow-up or pressing proposals. The pilot study showed improved supplier work process, correspondence with patients, and eventually nature of care (Kumar et al., 2016).

Various other clinical fields are installing comparable frameworks for monitoring that consolidates PHR/EHR, wearable advancements, and CDSS, including, however not restricted to, cardiovascular breakdown (cardiology), hypertension, sleep apnea, gentle/senior care, and more. As PHRs have gotten further developed with CDSS abilities, there has likewise been expanding accentuation on the plan of these frameworks to serve shared decision making among patients and suppliers and be intuitive devices to make patients more educated/associated with their care. However, PHRs that solitary fills in as a storeroom for wellbeing data are presently seen as coming up short, especially by patients themselves (Fugi, 2012).

## **2.6 Challenges of CDSS**

### **2.6.1 Divided Work Processes**

CDSS can upset clinician work process, mainly on account of independent frameworks. Numerous early CDSS were planned as frameworks that required the supplier to archive or source data outside their workspace. CDSS likewise upset work processes whenever planned without human data preparation and practices at the top of the priority list. Accordingly, CDSS has been planned to utilize the 'think-aloud strategy to show professionals' work processes and make a better usability

framework (Kilsdonk et al., 2016). A disrupted work process can prompt increased psychological exertion, more time needed to finish assignments, and less time facing patients. In any event, when CDSS are very much coordinated within existing data frameworks, there can be a separation between face-to-face connections and cooperation with a computer workstation. Studies have discovered that professionals with more experiential information are less inclined to utilize and bound to supersede CDSS (Dowding, 2009).

### **2.6.2 Alert Fatigue And Inappropriate Alerts**

Studies have found that up to 95% of CDSS alarms are irrelevant, and doctors cannot help contradicting or doubt alerts periodically.85 other occasions, they do not read them. If doctors are given redundant/irrelevant alarms, they can experience the ill effects of alert fatigue (Khalifeh and Zabani, 2016). Therefore, disruptive cautions should be restricted to more dangerous or essential contraindications, like genuine hypersensitivities. Be that as it may, even hypersensitivity cautions can be inaccurate, and clinicians will frequently confirm themselves, mainly if the source is another site/hospital/practitioner (Van later, 2018). Medication cautions can likewise be explicit yet unimportant when taken outside any connection to the subject at hand. For instance, an alert against utilizing broad-spectrum antibiotics, such as vancomycin, might be improper in the ICU. A caution against duplicate prescriptions might be unseemly in inflammatory bowel infection clinics, where a similar class of medication can be applied through various organization courses for expanded impact (Ash et al., 2007).

### **2.6.3 Impact On User Skill**

Before CPOE and CDSS, medical care suppliers, pharmacists, and nurses were depended upon only to double-check orders. CDSS can feel that checking the precision of a request is superfluous or automatic (Ash et al., 2007). It is likewise imperative to consider the expected long-term impact of a CDSS on users. Over time a CDSS can apply a training impact, so the CDSS itself may, at this point do not be needed. Conversely, suppliers may grow dependent or trusted with CDSS for a particular

task.<sup>89</sup> this might measure up to utilizing a calculator for numerical activities throughout a significant period and afterward having less fortunate mental mathematical abilities. It is conceivably risky as the client has less freedom and will be less prepared for that undertaking should they change to an environment without the CDSS (Goddard et al., 2011).

CDSS might be reliant upon computer education. Lack of technological capability can be hindering while being attracted to a CDSS. This can change by the plan subtleties of the CDSS. However, some have been discovered to be excessively intricate, depending a lot on client skills (Devaraj et al., 2014). Systems should expect to remain as near to the center usefulness of the previous framework as could be expected. Regardless, all new frameworks have a learning period. Thus pattern assessments of clients' technological competence might be proper. Further training would then be given to utilize CDSS capabilities fully, or a more specific direction joined into the CDSS' proposals themselves. These data could be carried out as information buttons to be non-disruptive (Cook et al., 2017).

#### **2.6.4 System And Content Maintenance**

Maintenance of CDSS is a significant but regularly ignored part of the CDSS life-cycle. This incorporates specialized maintenance of frameworks, applications, and databases that power the CDSS. Another test is maintaining the knowledge base and its principles, which should keep as fast as the quickly changing nature of clinical practice and clinical rules. Indeed, even the most exceptional medical services foundations report trouble keeping up with the latest information changes. Order sets and the algorithmic guidelines behind the CDSS have been distinguished as especially difficult (Ash et al., 2007).

The operational effect of poor information quality and wrong substance of EHRs and CDSSs depend on information from outside, unique frameworks, which can make strange insufficiencies. For instance, some CDSS modules may empower requesting in any event when the clinic needs

sufficient supplies. In an investigation by Ash et al. (2007), experts showed that Hem occult (test for occult blood in feces if there is bleeding in the intestines or stomach) tests or pneumococcal antibodies at their clinic inventories run out rapidly. However, this is not conveyed to the CDSS.

Medicine and problems records can be hazardous, if not refreshed or utilized suitably. At one site, the prescription list maybe a rundown of allotments, which implies patients may or may not be taking them (and subsequently should, in any case, be asked in person) (Ash, et al., 2007). Other medicine records are produced from CPOE arranges only, hence as yet requiring manual affirmation that patients are taking the drug. Frameworks that make it simple to recognize these are ideal. It is likewise a significant area where PHRs could make a solution, by gathering prescription adherence information straightforwardly from patients. In ineffectively planned frameworks, clients may create workarounds that bargain information, like entering conventional or inaccurate data (Ash et al., 2007). The knowledge base of CDSS is reliant upon unified, enormous clinical information storage. Quality of information can influence the quality of decision support. If information assortment or contribution to the framework is unstandardized, the information is successfully ruined.

You may plan a framework for use at the place of care, however, when applied to true conditions and information, would not be used as expected. The significance of utilizing informational principles like ICD, SNOMED, and others, cannot be downplayed. Absence of movability and compatibility despite continuous advancement for pretty much thirty years, CDSS (and even EHRs in general) experience the ill effects of interoperability issues. Numerous CDSS exist as unmanageable independent frameworks or exist in a framework that cannot communicate with different frameworks.

What makes movability so hard to accomplish? Past programming intricacies that can make incorporation troublesome, the variety of clinical information sources is a challenge. In addition, there is a hesitance or seen hazard related with moving personal patient data. Emphatically,

compatibility norms are consistently being created and improved, like Health Level 7 (HL7) and Fast Healthcare Interoperability Resources (FHIR). These areas of now being used in business EHR vendors (Index-FHIR, 2018). Several government agencies, clinical associations, and informatics bodies effectively support some in any event, ordering the utilization of these interoperability principles in wellbeing systems (European Commission Report, 2019).

The cloud also offers an expected answer for interoperability (and other EHR malfunctions, such as information sync and software updating). Cloud EHRs have open engineering, more up-to-date guidelines, and more adaptable availability to other systems (Bresnick, 2015). Likewise, it is a typical confusion that information put away on a cloud is more endangered. This is not evident because electronic EHRs are needed to store insignificant information level stockpiling communities with cutting-edge encryption and different shields. They should conform to public information security principles, including the Health Insurance Portability and Accountability Act (HIPAA) in the USA, Personal Information Protection and Electronic Documents Act (PIPEDA) in Canada, or the Data Protection Directive and General Data Protection Regulation (GDPR) in Europe, to name a few (Rodrigues et al., 2013). They can be similarly as protected (or similarly as powerless) as conventional, worker-based architecture. Indeed, fewer individuals regularly approach decoded information in cloud storage places versus worker-based records (Rodrigues et al., 2013).

### **2.6.5 Financial Challenges**

Up to 74% of those who owned a CDSS say that financial suitability stays a struggle (Kabachinski, 2013). Outset expenses to set up and coordinate new frameworks can be significant. Ongoing expenses can be an issue inconclusively as new staff should be prepared to utilize the framework, and framework updates are needed to stay updated with current information. Results from cost investigations of CDSS executions are mixed, disputable, and sporadic (Jacob, 2017). Whether an intercession is cost-effective relies upon a broad scope of elements, including those particular to the political and technological environment. Cost advantage appraisal can be restricted, with difficulties,

such as an absence of normalized metrics (Jacob, 2017). This is an arising research territory, and much work should be done to propel our comprehension of the financial impacts of CDSS.

### **Summary:**

In this study, we created a CDSS for breast cancer, and this system will work to help the oncologist in diagnosing cancer by using artificial intelligence technology to calculate the stage of the disease. Then, the CDSS system will evaluate the inputs (the patient's clinical tests), and then proposes appropriate specific protocols for diagnosis according to Global guidelines (NCCN). It is worth mentioning that no one has ever used the CDSS system to diagnose and treat breast cancer, and we have benefited from the advantages of the CDSS system mentioned in the literature. In addition to overcoming the challenges of CDSS, we will also test the important medical results, by introducing real cases, with the help of experts (oncologists) in Palestine, and evaluating the results, and determining the efficiency and effectiveness of this system. To achieve this, we chose the cancer treatment center in Palestine, which is (Beit Jala Governmental Hospital).

## **Chapter Three: Research Methodology**

### **3.1 Introduction**

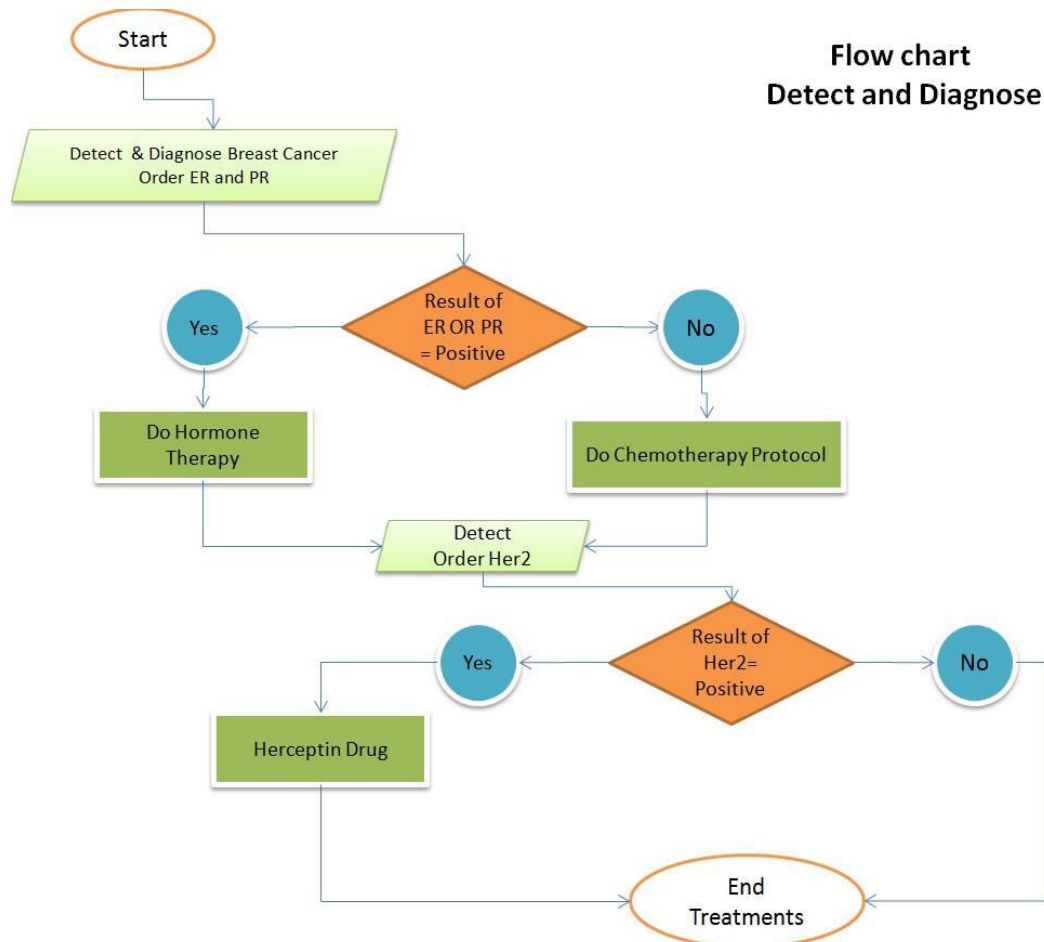
In this chapter, study design, study setting, study tools, data gathering methods, data management, data analysis, and ethical considerations will be presented.

### **3.2. Study Design**

To achieve the primary goal of the research problem, we created a clinical decision support system that helps oncologists diagnose and treat breast cancer. This will help researchers in the future to do any study of the disease because the system contains all the features (parameters) related to the disease.

The clinical decision support system was created by two programmers, the researcher and a programmer working in the Palestinian Ministry of Health . It took four months to design the

database, which contains all the parameters, characteristics, and features of patients as well as the characteristics of breast cancer disease, and the database tables were linked with relationships that facilitate the work of the system, Clinical Decision Support System has been implemented in Beit Jala Governmental Hospital and Jenin Governmental Hospital.



Figure(3.1):Flow Chart for detect and diagnose.

### 3.3 Study Settings

Beit Jala Governmental Hospital has four departments for diagnosing and treating malignant breast tumors (Breast Cancer and Mammogram Unit, Pathology Lab Department, Surgical Oncology Department, Oncology Department). Beit Jala Governmental Hospital provides free treatment services to all oncology patients in southern Palestine (Bethlehem and Hebron). The management of Beit Jala Hospital granted the initial approval, the Palestinian Ministry of Health, and the oncologists

of Beit Jala Hospital to adopt the strategy to support cancer patients. Because of the careful characterization and separation of the intelligent framework used, all entered clinical information was examined at the moment (months), e.g., knowledge of each diagnosis and each clinical-stage, number of patients accepting treatment agreement. In the long term (after a few years of use), an example can be taken from many patients, and we can get predictions about the best treatment agreement for each diagnosis.

### **3.4 Study Tools**

The researcher designed the database so that it is divided into two parts, the first section is the patient's data that will be entered into the system in the clinic. It is also divided into two parts. The first part is the personal data (full name, ID number, gender, phone number, place of residence (city and village) Marital status, smoking (smoker, non-smoker, former smoker, unknown), the second part of the patient's file, the medical data, consisting of the laboratory and radiological tests that the patient performed or was required to perform.

The patient database (the patient's personal and medical information), with the knowledge base taken from global medical sites and the doctor's experience, was integrated to interact within the clinical decision support system and help the doctor decide on the most appropriate therapeutic protocol. The protocols were arranged based on the globally classified protocols used for each stage of the disease.

The disease is classified into four stages, where the expert system deduces the stage based on the parameters of the laboratory tests, specifically the pathological tests; the parameters are (TNM, ER, PR, Her2).

The tool for collecting quantitative data in this study, by designing a clinical decision support system, through which not only the characteristics of the disease and medical information for patients are entered, but also helps the oncologist, and facilitates the process of choosing the optimal

treatment for the most complex and most prevalent disease, the process of designing the system (CDSS) and filling in the data of more than 90 patients was successfully completed.

The researcher designed a questionnaire which was evaluated and accepted by reviewers from inside and outside the university. The questionnaire contains questions that were asked to the oncologist, who used the system (CDSS), intending to evaluate it, through interviews. The questionnaire was designed to cover all aspects of the system (features, advantages, functions, usages). A copy of the carried questionnaire is shown in appendix (1).

### **3.5. Research Population And Sampling Method**

The researcher was present in the oncology clinic daily for two months to mobilize the cases, in the clinical support system, follow up their treatment, obtain data for breast cancer, as well as evaluate the system by the oncologist. The number of oncologists in governmental hospitals is six specialists. The researcher attended the oncology clinics in Beit Jala Hospital and the oncology clinic in Jenin Governmental Hospital. Thus, the researcher has taken medical data from all oncologists in public hospitals in the south and north.

The number of cases that were entered into the clinical decision support system is 95 cases from all Palestinian governorates. An interview questionnaire was prepared with the doctors who used the clinical decision support system to evaluate the new system (the expert system) specialized for the diagnosis and treatment of breast cancer, to cover the qualitative study.

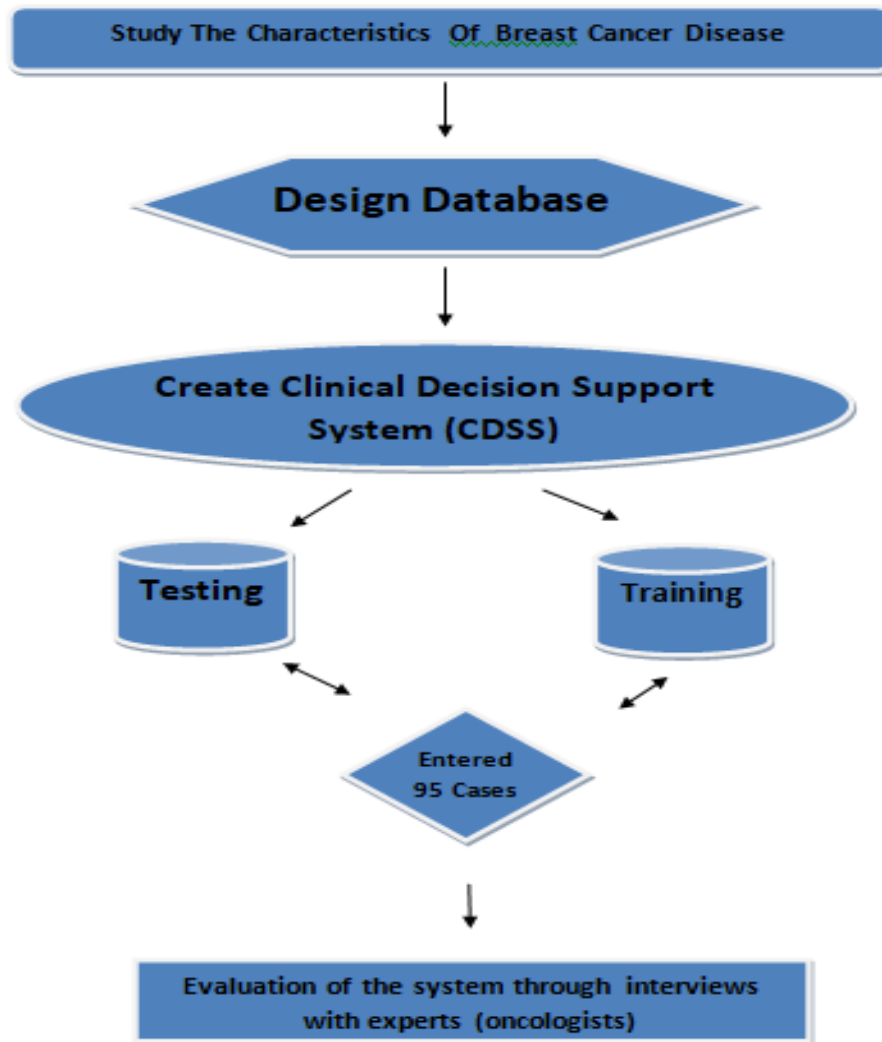
This thesis aims at an expert system for breast cancer diseases (Al-Amal clinical decision support system), intending to assist clinicians in making the appropriate treatment decision for the patient, providing the optimal way to deal with the disease and its characteristics. In addition to providing health data arranged and organized for statistics and studies, to demonstrate the availability of advantages and characteristics mentioned in the Clinical Decision Support System, we tested the workflow of the system by filling (95) cases with the help of oncologists in governmental hospitals

(Beit Jala Governmental Hospital, and Jenin Governmental Hospital). Furthermore, we conducted interviews with oncologists in the mentioned government hospitals, and their number was (6) from a total of population (8) oncologists, intending to evaluate the proposed system by experts (oncologists).

The researcher prepared the questionnaire questions, by focusing on the ideas and issues that the system intelligently implements, such as, deducing the stage of the disease after entering the results of specific pathology tests, filtering options and suggestions for treatment protocols based on the stage of the disease and other pathology tests, oncologists were also asked about the importance of that suggestions. Therapeutic and prediction of the optimal and most appropriate protocol, even if these carefully calculated electronic operations are useful in reducing errors, and maintaining patient safety. In addition to other advantages and strengths that speak of ease of use, arrangement and organization of diagnostic, treatment procedures, and application of the therapeutic protocol chosen by the oncologist.

### **3.6. System Management And Analysis Framework:**

Before preparing the proposal for this study, the steps and stages of preparing the system were identified, from its study to its implementation according to a plan. The study framework for establishing a clinical decision support system for oncologists contains the following steps, studying the characteristics and determinants of breast cancer, then creating, designing, and analyzing the database. creating a clinical decision support system, testing the system, training oncologists, entering 95 cases, and evaluating the clinical decision support system suggested by experts (oncologists). The proposed framework is shown in Figure (3.1).



Figure(3.2):System Management and Analysis Framework

### 3.6.1 Study the Characteristics Of Breast Cancer Disease:

The researcher studied the characteristics, determinants, and parameters of the disease in terms of studying the diagnostic steps, the types of tests used in the stage of diagnosing the patient, and then the mechanism of calculating and determining the stage of the disease, since treatment does not start before diagnosing the type and stage of the disease, and under the guidance of experts (oncologists), the researcher studied the treatment protocols used globally are the American guidelines (National Comprehensive Cancer Network( NCCN Guideline), and with the help of a cancer expert(oncologist), the possibilities and suggestions of treatment have been linked to the results of

laboratory, pathology and radiological tests, and the stage of the disease. The stage of studying the characteristics of breast cancer, the determinants of diagnosis, and the American global guidelines (NCCN) for therapeutic protocols took more than two months.

### **3.6.2 Analyze And Design Database**

The researcher designed the database, which contains two parts; the first part contains the knowledge base, which contains the treatment protocols according to the international American guidelines, while the second part contains the patient's personal and medical diagnostic information tables. With the help of another computer programmer, the researcher linked the database tables together accurately. Ultimately, the aim of entering data that is easy to link together within knowledge bases, that ensure facilitating the diagnosis process, then suggesting the optimal treatment protocol, which is also available in the database, which makes the expert system very flexible in the process of modification in the future, for example adding a new treatment plan within the database tables that appear easily and clarity in the CDSS system. The analysis and design phase of the database took more than three months.

The Phase of designing and implementing the clinical decision support system database was divided into several stages: Figure (3.2)

1. The Phase of designing and building the database, and the knowledge base by referring to specialized doctors (oncologists), as well as specialized medical advice sites such as (NCCN Guidelines).(NCCN Guideline,2021)
2. The Phase of building and creating the interface (interactive screens) for the user, in which the stages of diagnosis and treatment appear organized in order (the diagnosis stage, the treatment phase before the operation, then the phase of breast surgery, finally the phase of postoperative treatment). The necessary diagnostic procedures such as the necessary lab tests, pathology test, CT-Scan, Mammogram test, MRI test, and X-rays, then when moving to the

stage of pre-operative treatment, the CDSS system proposes specific treatment protocols according to the results of the examinations and the stage of the disease.

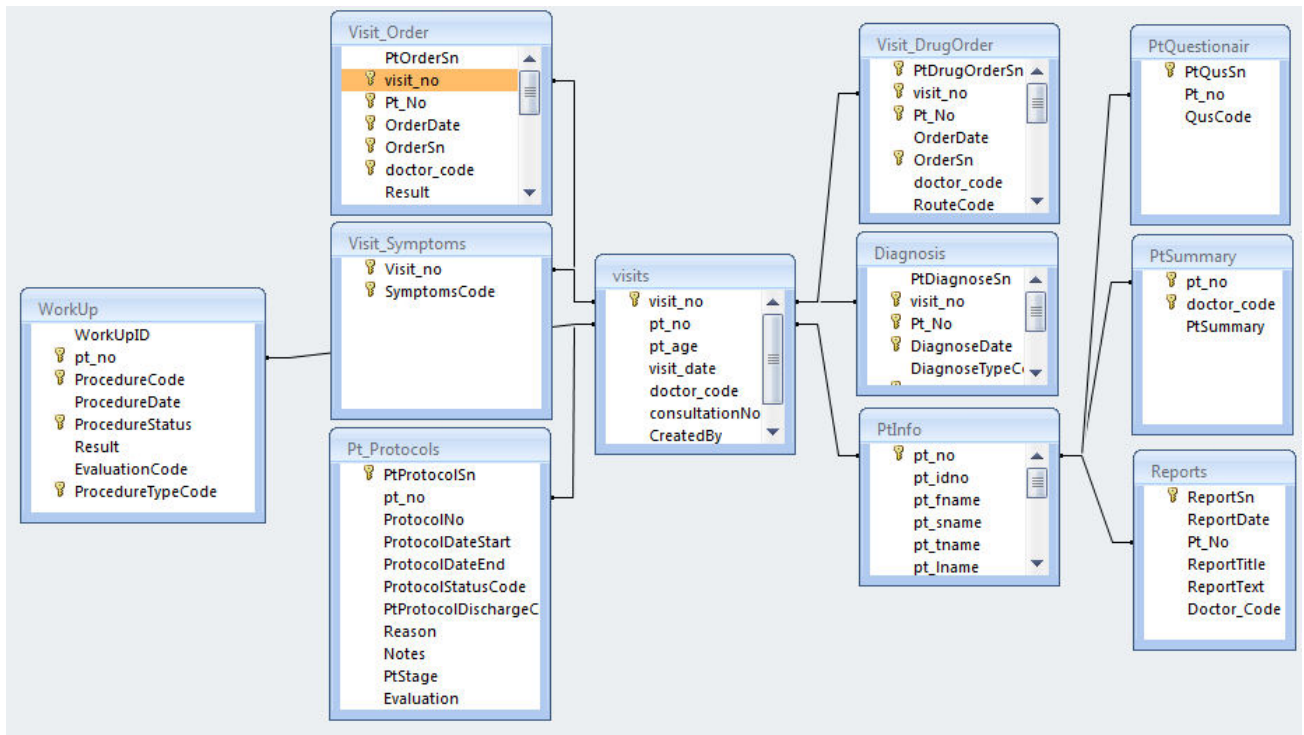


Figure (3.3): Database Diagram for Diagnosis Breast Cancer.

To achieve the main objective of the system (CDSS), the work steps in the system with Workflow are combined with the following main steps:

- Collects relates and visualizes relevant patient-specific information along the diagnostic pathway for breast cancer.
- The system automatically selects specific protocols of potential treatment, based on the stage of disease and diagnosis, based on evidence-based guidelines, and shows the percentage of selection of each protocol according to the number of similar cases that used the protocol.
- Facilitates objective decision-making by the oncologist, in the clinic or specialist medical center, through interconnected patient data and preferences, providing transparent insights into the time of appropriate diagnosis and treatment.

### 3.6.3 Create Clinical Decision Support System (CDSS)

The researcher, with the help of a computer programmer, designed the CDSS system screens using a programming language (C-SHARB), where the programming language allowed us to use all the ideas of artificial intelligence in the proposed system, such as deducing the stage of the disease automatically by the system based on specific laboratory tests (Pathology tests).

The user interface (screens) has been arranged according to the workflow of the oncologist in the clinic, in the first screen, a file is opened for the patient (personal information), while the second screen is for preparing an appointment. Custom fields according to the database tables, where a screen (Questionnaire) has been allocated to include information related to risk factors, occupation, and family history of the disease, in addition to the patient's personal information, which is filled out for the patient in the first visit for one time, and the visit screen (medical consultation) was prepared as well as a cumulative summary of the case in the same way. The visit screen, where the oncologist writes notes and explains the details of the diagnosis and treatment in the visit and adds important information such as the patient's medical history in the summary field, the information appears on the date of adding the consultation notes. And then the symptoms and diagnosis screen, followed by the main screen of the system (CDSS), which contains the treatment protocols according to a classification of the results of the tests added by the oncologist during the visits, where the recommendations of the therapeutic protocols change by, changing the results of the tests, and in this screen is also calculated the stage of the disease for each patient, which is four stages. It also appears automatically based on the three pathology determinants called (TNM), which are related to the size of the tumor(T), the number of lymph nodes(N), and the spreading factor metastatic (M).

As well as the programming and application therapeutic protocol screens that the oncologist has chosen among the many suggestions from the system. The clinical decision support system design phase took more than four months.

### **3.6.4 Testing And Training For CDSS**

The researcher, in cooperation with the oncologist, tested all the data entered in the databases and made sure that there is no shortage of information, especially information related to treatment and protocols.

The system's working mechanism and the validity of the evidence-based information were tested and accurately linked to each other, by entering real medical data for breast cancer patients at Bait Jala Governmental Hospital.

Posterior, five oncologists at Bait Jala Governmental Hospital and one oncologist at Jenin Governmental Hospital were trained by entering complete medical information about 95 breast cancer cases, during their follow-up of the oncology clinic. The data entry phase and follow-up work on the expert system (CDSS) took more than three months. The training included also real patients who visited hospital cancer departments and clinics, filling up diagnosis and clinical data and all the medications they used through their treatment journey.

### **3.6.5 Evaluation Of The System Through Interviews With Experts (Oncologists):**

The researcher made a presentation for the latest updates to the CDSS, in the office of the head of the oncology department, to discuss the benefits of the expert system, and its strengths through exchanging ideas, highlighting the importance of the system and comparing it with the old system, then the researcher conducted interviews with oncologists in governmental hospitals, separately, to maintain the independence of each expert's ideas, each oncologist is subjected to the same questionnaire so that the experts are not affected by each other's opinions. The interviews took several days (a week), and their analysis took another week.

### **3.7. Ethical Considerations:**

First of all, and to start this research, the approval of the College of Graduate Studies at the Arab American University - Palestine (AAUP), was obtained after discussing the research proposal by the research committee. After that, the approval of the administration of Beit Jala Governmental

Hospital and the Ministry of Health was obtained to collect the required data, especially since the researcher was forced to work in the clinical departments to fill out patients' cases, and hold interviews with doctors to evaluate the smart system, and it is worth mentioning that the researcher works in the Information Technology Department in the Palestinian Ministry of Health. which facilitated the study procedures, data filling and testing, training, and project implementation.

## **Chapter Four: Results**

### **4.1 Introduction**

This chapter, a discussion of the results of this study, which the results were divided into two parts, the first section is the practical and experimental section, represented by the establishment of a Clinical Decision Support System (CDSS), the system specialized in the diagnosis and treatment of breast cancer. The second section discusses the evaluation of the CDSS proposed by the users of the system (oncologists).

### **4.2. Experimental Results:**

The (CDSS) achieved the expected results. The story of establishing the (CDSS) began after asking the oncologists about their needs, what their hopes, and desires to develop on the existing health information system, which does not meet the needs of the oncologist, especially since it was not designed for a specific disease, as it is a health information system General for documenting cases admitted to the governmental hospital, regardless of the type of disease that the patient suffers from. It covers the specialties of surgical diseases, internal diseases, cardiology, kidney diseases, pediatric diseases, etc....

**As shown in the attached figures, which explain the task of each screen in the system:**

**Patient Information Screen:** contains the patient's personal information, that is added or modified through the buttons appearing in the middle of the screen, (New) button to add new patient information, (Cancel) button to cancel the process of entering data or modifying patient data, (Edit)

button to modify personal information for a pre-existing patient, the (Search) button is used to search for a patient in the list of patients, the (Stage) button is used to filter patients according to the stage of the disease, the (Protocol Step) button is used to filter patients according to the stage of the treatment protocol currently used for the patient, as for the tape the top identification of the patient (the active case), to which the medical information will be added in all subsequent screens. When you press the mouse button on any patient from the list of patients, his/her main information appears in the top identification bar where it appears (patient's file number, name, visit number, age, date last visit). In addition to the alerts pane on the right of the screen, which shows alerts to the oncologist, if he chooses a specific treatment for a patient, and has side effects on the kidneys or the heart, the system automatically shows an alert that a kidney function test is required, as shown in Figure (4.1)

The screenshot displays the 'Patient Information' screen. At the top, there are input fields for 'Pt No.', 'Name', 'Visit No.', 'Age', and 'Process Date' (set to Saturday, December 18, 2021). Below these are tabs for 'Patients Info', 'Appointments', 'Visits', 'Symptoms & Diagnose', 'Questionnaire', 'CDSS', 'Treatment Plan', 'Drugs', 'Reports', and 'Apply Session'. The 'Patients Info' tab is active, showing a form with fields for personal and medical details. A 'BREAST CANCER SUPPORT' logo is prominently displayed. Below the form are buttons for 'New', 'Cancel', 'Edit', and 'Search'. There are also checkboxes for 'Stage' (checked) and 'Proced' (checked), with dropdown menus for 'Stage 1' and 'Surgery'. At the bottom, a table lists patient records with columns for 'pt\_no', 'pt\_idno', 'pt\_fname', 'pt\_sname', 'pt\_lname', 'gender', and 'dob'. The table contains several rows of data, with the first row highlighted in blue. On the right side, an 'ALERT' panel is visible, featuring a red header, a checkbox for 'All', and a text area for 'AlertMSG'.

pt_no	pt_idno	pt_fname	pt_sname	pt_lname	gender	dob
510	984656462				M	21/08/195
513	401704796				F	03/07/202
514	999657091				F	07/06/196
516	900382276				F	16/11/197
517	974011140				F	10/05/195
518	988245510				F	01/01/195

Figure 4.1: Patient Information screen

**Visits Screen:** This screen contains a field of medical notes (Consultation Notes), where the oncologist writes his medical notes for a visit, and a field of (Patient Summary) where the oncologist

writes in this field the essential information, which is suitable for forming a medical history for the patient, at the bottom of the screen appears the history of previous visits and the current patient, the entered medical information is stored in the database, as shown in Figure (4.2).

visit_no	pt_no	pt_age	visit_date	doctor_code	consultationNote	CreatedBy	CreateDate
945	517	63	05/07/2021		IS A CASE OF R...		05/07/2021
*							

Figure (4.2): Visits Screen

**Symptoms and Diagnosis Screen:** This screen contains a list of symptoms of breast cancer that appear on the patient, when selected, it appears at the bottom of the screen, the oncologist could select more than one type of disease symptoms, in addition to the global diagnostics field according to the international classification disease - oncology (ICD-O3), as shown in Figure (4.3)

Pt No. 514 Name Visit No. 1044 Age 56 Process Date Saturday, December 18, 2021

Patients Info Appointments Visits **Symptoms & Diagnose** Questionnaire CDSS Treatment Plan Drugs Reports Apply Session

### Symptoms

Filter

Symptom	SymptomsDesc
1	Hard breast
2	Soft breast
3	Change in size, shape or feel of your breast

Symptom Date: 18/12/2021

Note:

PtSymSn	SymptomsC	SymptomsI	SymptomsI	Notes	Pt_no
38	1	Hard bre...	18/12/2...		514

### Diagnose

Filter

ICDCode	ICDDesc
C50.0	Malignant neoplasm of nipple and areola
C50.01	Malignant neoplasm of nipple and areola, fem...
C50.011	Malignant neoplasm of nipple and areola, right...
C50.012	Malignant neoplasm of nipple and areola, left f...

Diagnose Type: Pre Diagnose

PtDiagnose	DiagnoseD	DiagnoseT	ICDCode	ICDDesc	visit_no
117	26/08/2...	Pre Diag...	C50.221	Malignan...	1044

Figure (4.3): Symptoms and Diagnosis Screen

**Questionnaire screen:** This screen contains information used to enter information related to risk factors, occupation, and family history of the disease, which is filled out once in the first visit just, and these data will be used statistically for future studies, as shown in Figure (4.4)

**CDSS Screen:** The most important screen in the system is the CDSS screen, which is used to fill in the medical data based on the diagnosis, such as pathology tests, radiological tests, mammography, CT scan, MRI, tumor marker, and other tests) related to the diagnosis. Once the results of these tests are entered, the system shows the stage of the disease, then the CDSS filters the available treatment options (chemotherapy and hormonal protocols) for that stage of the disease, where the system

suggests treatment protocols for each stage, and arranges them according to the most used by other doctors, as shown in Figure (4.5)

Pt No. 514 Name [ ] Visit No. 1044 Age 56 Process Date Saturday, December 18, 2021

Patients Info | Appointments | Visits | Symptoms & Diagnose | **Questionnaire** | CDSS | Treatment Plan | Drugs | Reports | Apply Session

**Risk Factor**

Filter [ ] [ ]

QusCode	QusDesc
1	nulliparity
2	alcohol consumption
3	obesity
4	homone use - contraceptives
5	homone use - ovarian stimulation dr...
6	homone use - Weight loss drugs

**Family History**

Filter [ ] [ ]

QusCode	QusDesc
28	None
29	Mother
30	Sister
31	G.father
32	G.mother
33	Aunt

**Occupation**

Filter [ ] [ ]

QusCode	QusDesc
16	nurse
17	physician
18	X-Ray technician
19	laboratory technician
20	Pathology technician
21	Radiologist

**Exist Risk Factor**

Q Desc		
homone use - contraceptives	1, 5, 8	

**Exist Family History**

Q Desc		
Mother	2, 5, 8	

**Exist Occupation**

Q Desc		
X-Ray technician	3, 5, 9	

Figure (4.4): Questionnaire screen

Pt No. 514 Name Visit No. 1044 Age 56 Process Date Saturday, December 18, 2021

Patients Info Appointments Visits Symptoms & Diagnose Questionnaire **CDSS** Treatment Plan Drugs Reports Apply Session

Chemotherapy **Homone Therapy**

Preferred Regimens **Certain Circumstances** Other Recommended Regimens

Protocol (docetaxel and cyclophosphamide) / Usage by 10

Medica	Medical	DoseTy	Dose	MedUni	ApplyTy	Duration	Cycles	Followe	Protoco
Targe...	Lapat...	-	1000	mg/m...	IV	Day 1			20
Targe...	Trast...	-	4	mg/m...	IV	Day 1		Targe...	20
Targe...	Trast...	-	2	mg/m...	IV	Day 1			20

Pt. Diagnostic Test

ProcedureDesc	ProcedureType	MaxOfProcedu	Result
T	PathologyTest	03/07/2021	2
N	PathologyTest	03/07/2021	1
M	PathologyTest	03/07/2021	0
ER	PathologyTest	03/07/2021	+
PR	PathologyTest	03/07/2021	+
HER2	PathologyTest	03/07/2021	-
Lumpectomy...	Surgery	16/07/2021	done ON 8/1...
Radiotherapy	Treatment P...	16/07/2021	done ON 30/...
Grade	PathologyTest	26/08/2021	2
Tumor Size	PathologyTest	26/08/2021	2.8 cm.
Tumor Type	PathologyTest	26/08/2021	invasive duct...
Right Breast	Side	26/08/2021	YES

ER PR Her2 T N M Stage Ki Grad Meno

+ + - 2 1 0 2-2B 2 !

Diagnose

Surgery

ProcedureDesc

Mastectomy +SLNB / Rt

Figure (4.5) : CDSS Screen

**Treatment plan screen:** After selecting the appropriate treatment for the case within the options specified in the previous screen (CDSS Screen), the user(oncologist) determine the number of sessions and duration of treatment, into the treatment plan screen to arrange and organize the dates of the treatment sessions. The system sets subsequent dates for the sessions based on the doctor's choice of the number of sessions only, as shown in Figure (4.6)

Pt No. 516 Name Visit No. Age 45 Process Date Saturday, December 18, 2021

Patients Info Appointments Visits Symptoms & Diseases Questionnaire CDSS **Treatment Plan** Drugs Reports Apply Session

9 **In process** Discharge as Worst Update

ProtocolDateStart	ProtocolDateEnd	Protocol	PtProtocolDischarg	Reason	Notes	PtStage
05/07/2021		Cancel	Worst			2
05/07/2021		Cancel	Worst			2
05/07/2021		Cancel	Stable			2

Dose	MedUnit	ApplyType	Duration	Cycles	OrderBy
60	mg/m <sup>2</sup>	IV	Day 1	Every 14 days 4 ...	1
80	mg/m <sup>2</sup>	IV	Day 1	Every week for 1...	3

Start On 12/02/2021  
 Every 14 Days  
 Cycle 4  
 AC+Taxol  
 Create Sessions

MedicationCode	MedicationDesc	Dose	ActualDose	Complication
37	cyclophosphamide	600		
35	doxorubicin	60		
37	cyclophosphamide	600		

18/12/2021-AC+Taxol  
 01/01/2022-AC+Taxol  
 15/01/2022-AC+Taxol  
 29/01/2022-AC+Taxol

Add

Figure(4.6): Treatment plan screen

**Apply Sessions Screen:** Nurses can use this screen to implement pre-programmed sessions by the oncologist, where the chemotherapy protocol appears on the screen automatically, according to the pre-set date. Treatment information is shown according to the doses and method of drug administration. The nurse enters information (length, weight) to calculate the equations (Body Surface Area) that determine the doses. The system automatically calculates the required doses; then the nurse continues to enter the session notes, if any complications or side effects occur, then signs the session, and enters an evaluation, as shown in Figure (4.7)

Pt No. 516 Name Visit No. Age 45 Process Date Saturday, December 18, 2021

Patients Info Appointments Visits Symptoms & Diagnose Questionnaire CDSS Treatment Plan Drugs Reports **Apply Session**

Date From 18/12/2021 To 18/12/2021 Age 45 Len 160 Wt. 70 AUC 5 Cr. 1 18/12/2 Save 271

Complication: No Complication Notes: Done Status: Done Save

Full Name	Session Date	Sess	Medication Code	Medication Desc	Dose	Actual Dose	Complication
إيئة احمد ناجي بزا	18/12/2021	AC+T	37	cyclophosphamide	600	1058.3	
وداد محمد رضوان	18/12/2021	AC2	35	doxorubicin	60	105.83	
			37	cyclophosphamide	600	1058.3	

**ALERT** All

AlertMSG

Figure (4.7): Apply Sessions Screen

**Drugs Screen:** The oncologist can order medicines for the patient. The medicines available on this screen are complementary, and pain relievers, which are given before or after chemotherapy, such as nutritional supplements, relieve stomach pain and strengthen bones. On the right of the screen, there is a field of alerts, which appears intending to warn the specialist of Certain risks, such as medication side effects, as shown in Figure (4.8).

**Reports Screen:** The system automatically collects personal and medical information about the patient, and displays it in the form of a report (Smart Report), summarizing the patient's condition in ascending order from the date of the first visit until the last visit, as shown in Figure (4.9) And Figure (4.10).

Pt No. 516 Name Visit No. 944 Age 45 Process Date Saturday, December 18, 2021

Patients Info Appointments Visits Symptoms & Diagnose Questionnaire CDSS Treatment Plan **Drugs** Reports Apply Session

Drug     Category Bone Strengthening Treatment

MedicationCode	MedicationDesc
67	zoledronic acid (Zometa)
68	pamidronate (Aredia)
23	Bone Strengthening Treatment (bisphosphonates)

Medication: zoledronic acid (Zometa)

Route: intravenous route طريق الوريد

Frequency: 1 x 1

QTY: 1

Note:

MedicationCode	MedicationDesc	Frequency	QTY	Expr1	doctor_code	Pt_No	PtDrugOrderSn	visit_no
73	calcium	1 Tab x 2 x 30	1	oral route	1	516	109	944
67	zoledronic aci...	1 x 1 x 1	1	intravenous ro...	1	516	150	944

**ALERT**  All

AlertMSG: Please Do Creatinine and BU...

Figure (4.8): Drugs Screen

Pt No. 516 Name Visit No. Age 45 Process Date Saturday, December 18, 2021

Patients Info Appointments Visits Symptoms & Diagnose Questionnaire CDSS Treatment Plan Drugs **Reports** Apply Session

Report Date: Sunda Report Title: د نضال الجبريني

ReportSn	ReportDate	Pt_No	ReportTitle	ReportText	Doctor_Code
1	23/08/2021	516	NIDAL REPORT	Is a Case of Malignant ...	0
9	01/08/2021	516	د نضال الجبريني		0
10	01/08/2021	516	د نضال الجبريني	RadiologyTest (CT-sca...	0

Font (-)  Font (+)

Chemotherapy ( (doxorubicin/cyclophosphamide) dose dense--> T weekly) On 05/07/2021  
 S/P PathologyTest ( ER (+)) On 05/07/2021  
 S/P PathologyTest ( HER2 (-)) On 05/07/2021  
 S/P PathologyTest ( M (0)) On 05/07/2021  
 S/P PathologyTest ( N (1)) On 05/07/2021  
 S/P PathologyTest ( PR (+)) On 05/07/2021  
 S/P PathologyTest ( T (2)) On 05/07/2021  
 S/P Chemotherapy ( (doxorubicin/cyclophosphamide) On 05/07/2021  
 S/P Hormon Therapy ( AI - Anastrozole (Arimidex)) On 12/07/2021  
 S/P Chemotherapy ( (doxorubicin/cyclophosphamide) On 12/07/2021  
 Is a Case of Malignant neoplasm of upper-inner quadrant of unspecified male breast On 01/08/2021  
 S/P Diagnose ( Malignant neoplasm of upper-inner quadrant of unspecified male breast) On 01/08/2021  
 S/P Surgery ( Lumpectomy +ALND / Lt (DONE ON 15/6/2016)) On 26/08/2021  
 Is a Case of Malignant neoplasm of central portion of breast, female On 26/08/2021  
 S/P Diagnose ( Malignant neoplasm of central portion of breast, female) On 26/08/2021  
 S/P Treatment PostOperative ( Radiotherapy (DONE ON 1/7/2016)) On 26/08/2021  
 S/P PathologyTest ( TNM (pT2N1Mx)) On 26/08/2021  
 S/P PathologyTest ( Tumor Size (< 1 CM = 7 X 5 MM)) On 26/08/2021  
 S/P PathologyTest ( Tumor Type (invasive ductal carcinoma)) On 26/08/2021  
 S/P RadiologyTest ( UltraSound ( LEFT BREAST 7 X 5 MM WELL DEFINED ECHOGENIC LESION )) On 26/08/2021  
 S/P Side ( Left Breast (LEFT)) On 26/08/2021

Figure (4.9): Smart Report

 	
<b>نظام دعم القرار السريري</b> Clinical Decision Support System	
<b>Name:</b>	<b>ID#:</b>
<b>Date of Birth:</b> 11/07/1983	<b>Gender:</b> F
<b>Address:</b> العنيل	<b>Mobile#:</b> حمارون :-
<b>Pl.#:</b> 533	
<b>22/08/2021</b>	<b>Procedure</b>
<b>Diagnosis:</b>	Malignant neoplasm of lower-outer quadrant of left female breast
<b>Side:</b>	yes
<b>Radiology Tests :</b>	CT- Scan
<b>Pathology Tests :</b>	Pathological TNM/ Stage 220 ER + PR + Her 2 + Ki67 7% Tumor Size 2,8 cm Tumor Type INVASIVE CARCINOMA Grade 2
<b>23/08/2021</b>	<b>Procedure</b>
<b>Treatment Plan:</b>	(LHRH) - Goserelin (Zoladex) - Cancel - - AC followed by docetaxel + trastuzumab - Cancel - - AC followed by T + trastuzumab - Complete - Improve (LHRH) - Goserelin (Zoladex) - In process - Stable
<b>27/08/2021</b>	<b>Procedure</b>
<b>Surgery :</b>	Lumpectomy + ALND / Lt

Figure (4.10): Medical Story Report

### 4.3 Evaluation CDSS System Qualitative Analysis:

Based on the open questions asked for the sample of the study, the researcher used the thematic analysis to reveal the results of the interview. Thematic analysis is one of the most common methods that started with coding the answers, then extracting the main themes. In this section, the researcher presents the qualitative results into themes as follows:

#### 4.3.1 Strengths & Advantages Of The Proposed System (CDSS)

Most of the oncologists who are the sample of this study confirmed that most of the advantages had been mentioned in the statistical data. All of them have exalted the proposed program and its

importance in diagnosis and making decisions regarding Breast cancer cases. Furthermore, all of the oncologists have affirmed that other advantages of the program are:

- 100 % stated that the proposed program saves time and effort for the d oncologist to enter medical information and refer to it.
- Undoubtedly, it prevents the doctor from making a mistake, whether it is a mistake in choosing an inappropriate treatment or an error in calculating the drug doses for each class of medicine. All samples have affirmed this advantage.
- 85 % of the sample stated that the proposed program is not confined only to oncologists. It helps the whole staff, including the nurses and the pharmacists.
- 100 % of oncologists stated that the proposed program is an expert program on breast cancer because it contains all the characteristics and determinants of the disease. It did not neglect any vital information to complete the diagnosis and treatment process.
- 100 % of the sample stated that the most crucial screen in the program is the session programming screen (the application of the therapeutic protocol). This means that there is no chance for any error, mainly because it is the most sensitive stage for the patient. Moreover, it gives the medicine, mainly because it is given through separate sessions. Using the current system, we cannot determine the number of patient sessions. Therefore, we have to keep that information as a note in a place other than the system.

In an attempt to compare the proposed program with the previous health information system, it is evident from the implementation and use of the new proposed program that the previous program is only suitable for documenting patient visits and does not help make the right decision. There is no mechanism to retrieve the entered data. So the oncologist is forced to review the patient's entire file,

which usually contains many visits, and does not perform any calculations for doses or stages of the disease. While the proposed program is considered a treatment program and not only confined to documenting and registration program, which provides the oncologist with all needed information about the case, and facilitates the review of the case's file.

As oncologist Hani AbulHowar said that “We in Palestine suffer from a lack of medical data that helps determine the causes of disease or ways to treat it. I think that this system, after years of its introduction and work on it, will give us accurate, organized statistical data that facilitates studies and research”. Which means that the proposed program will play an essential role in facilitating the task of deciding about the most appropriate treatment for the case by offering treatment options after appropriate filtering using international guidelines? In addition, most doctors confirmed that the proposed program attributes with ease of reference to the entered information by arranging and organizing a place designated for each information and through intelligent reports that the system collects and displays automatically without the doctor's request.

‘Dr. AhamdQrai added that the most important advantage of the proposed program is helping the doctor choose the treatment protocol in a way controlled by the system. He said that “An example of this is that the system does not allow the doctor to choose a Hormonal treatment with chemotherapy at the same time, and the system gives the doctor alerts about the necessity of conducting tests for the patient according to certain selected medicines, as this feature did not exist in any system before.” This means that the proposed program is unique on the local level and in the international level of medical services from the perspective of local oncologists who graduated from international universities. They are on the lookout for developments in the breast cancer field.

### 4.3.2 CDSS's Mechanism Of Raising The Level And Quality Of The Services

The oncologists who formulated the study sample confirmed that the proposed program has a significant role in raising the level and quality of the services provided to the patients. Throughout the role of the program in regulating the doctor's work, which shortens the patient's many visits to the hospital, in addition to that, the program saves the doctor's time in the clinic. As well, the program regulates the screen for giving doses, especially in the case of printing a pre-programmed dose schedule card for the patient with dates of attendance to take the doses, which leads to fewer errors and mistakes in taking the upcoming treatment.

Compared with the previous program, it was difficult for the oncologist to write a detailed report about the patient's medical history. The patient was constantly requesting reports about his condition, examinations, and medications to present them to a doctor outside the hospital and who might be outside the country, as 95% of oncologists stated. In addition, Dr. Nayef Casabreh' stated that medical information was scattered and difficult to refer to in a short time as for the previous system. While, 100% of doctors stated that through using the clinical decision support system, the doctor can use the patient's story report (Medical Story), extract a detailed report arranged by date on the patient's condition mentioned in it (diagnosis, stage, examinations and x-rays, treatment and evaluation from its beginning to its end).

Another mechanism of raising the level and quality of services for the patients has been mentioned by Dr. AhamdQrai' is that this system organizes the doctor's work. Which saves the patient many visits to the hospital? It also saves the doctor's time in the clinic. It also organizes the screen for giving doses, especially if the pre-programmed dose appointment card is printed for the patient with the attendance dates. Another unique mechanism that raises the level and quality of services provided to the patients, according to Dr. NidalAljebri, is that the patient benefits from the doctor's time instead of the doctor spending a long time entering data and waiting for the decision to choose

the optimal therapeutic protocol after extensive study and several sessions in the clinic. This means that the doctor allocates the entire time of visit to the patient, not only for entering the patient's data. That allows the oncologist to interact with the patient more than the previous system. Interacting with the patient is essential, as the literature stated, which benefits the patients more than previous ways of short interaction.

### **4.3.3 The Role Of CDSS In Monitoring And Follow Up**

The perspectives of the sample of oncologists have varied regarding the proposed project's role (CDSS) in monitoring and following up with the patient case. As mentioned in the advantages of the proposed program, it allows the oncologists to follow up with the case even though the oncologist has quite the hospital, or any other condition happened. In addition, the program allows oncologists to quickly follow up from the end procedures taken toward treating the patients and no need to spend much time reviewing the whole file.

Herein, different perspectives of the role of CDSS in monitoring and following up with the patient, stated by the doctors who have been interviewed:

- Since the system allows the oncologist to program the treatment sessions, the patient is given precise and pre-defined appointments, which provides safety and security for the patient from being given the wrong treatment.
- Through the main screen, a filter is available for patients according to the stage of the disease (Stages) or according to the diagnostic and treatment stage at which the patient arrived.
- This system gives accurate statistical reports about breast cancer according to the characteristics, determinants, and measures of the disease. I can say that in the past, oncologists were not able to study cases or even study the disease as a whole.
- The resident doctor in the Oncology Department and the Day Care Department can study cases with ease, as this system is suitable as an educational program, and we advise medical

students to use it to study because it contains scientific references in addition to cases of patients.

- This system contains the characteristics and determinants of breast cancer disease, arranged according to the stages of treatment and within the (Work Flow) followed, even the arrangement of the screens in this system, installed in an orderly manner according to the stages of tracking the disease. Since at the diagnosis stage, certain tests must be requested and their results entered, to be performed after the system arranges treatment options alone, and after programming the sessions for the chosen therapeutic protocol, the patient's medications appear automatically in the list of sessions application at the nursing benches.
- The service of extracting a medical report for the patient arranges the patient's information in an order that summarizes the patient's condition, which makes it easier for the doctor to read any patient within a few seconds. The doctor was most tired of searching for specific medical information about the patient in the previous system.
- It is possible for future studies on the quantities of medicines consumed through this system, as they are expensive medicines, and it was difficult in the past to conduct any study that allocates the quantities of medicines dispensed.
- The proposed system automatically collects a detailed report on the patient, from the information previously entered during the patient's repeated visits in an orderly manner, which facilitates the process of following up on the patient by the same doctor or another doctor.
- The main screen allows the doctor to filter patients according to the stage of the disease or according to the follow-up point at which the patient arrived (that is, it determines the number of patients in the diagnosis stage, the number of patients in the treatment stage before the operation, and the number of patients referred for surgery).

- This system gives accurate statistical reports about breast cancer according to the characteristics, determinants, and measures of the disease. For example, Dr. Hisham Al Amleh said that “throughout the proposed program I can say that it was not previously possible for an oncologist to study cases or even study the disease as a whole”.
- The number of screens and fields is limited and easy to use, most of the data is selected by clicking on the correct option. As Dr. Hani Abul Howwar said “as this service does not exist in the computer systems that I used previously. In addition, I had to spend a long time printing the protocols, names of medicines, doses, and methods of giving them, as for the clinical decision support system that is the proposed program, the doctor uses specific buttons and enters health data in specialized fields that are easy to refer to at any time in an organized manner.
- The service of extracting a medical report for the patient arranges the patient's information in order, summarizing the patient's condition, which makes it easier for the doctor to read any patient within a few seconds instead of reviewing all the patient's previous visits, which could be 50 or more.
- The possibility and ease of the doctor's follow-up to any patient even if he was not following his treatment from the beginning. As Dr. Abdallah Altal said that “if the patient decides to withdraw for treatment in another country and asks me as a doctor to take a detailed report on his condition, this system gives me a report arranged in ascending order according to the date, and detailed about all the information entered about Patient”.

#### **4.4 Evaluation Of CDSS System Results (Quantitative Analysis)**

To verify the achievement of the main aim of this study, which is to create a clinical decision support system (CDSS) for assisting oncologists in diagnosing and treating breast cancer. First, however, testing the system, training the oncologist to use it, and introducing ninety-five cases of

breast cancer, the researcher conducted interviews to evaluate the system from the users' point of view (oncologists) in government hospitals. According to the analysis of the interviews, it was found that the users responded with a high rate to the benefits and advantages of the clinical decision support system, in terms of ease of use and saving time and effort, up to the use of artificial intelligence methods in processing the data entered on the patient to conclude and suggest an appropriate treatment for the patient, calculate his/her therapeutic doses of medicines, and display the patient's medical data in an automatic, easy and clear manner that facilitates the work of the oncologist.

The analysis of the interviews showed that the evaluation rate of the system is (5.00), moderate evaluation (2.34-3.67), and the highest (3.68-5.00), which indicates that the system succeeded in achieving the expected advantages and benefits. As shown in table (4.1)

### Mean Scale

1.00 – 2.33	Low Evaluation
2.34-3.67	Moderate Evaluation
3.68-5.00	High Evaluation

Table (4.1): Statistical Analysis: Mean Scale

The analysis of the results showed that the mean of benefits achieved (5) out of (6), as the advantages that got the highest success rate are the followings ( saving time for the doctor, adopting global evidence-based guidelines (NCCN guidelines), facilitating the process of accessing medical information easily, quickly and in an organized manner for each patient, summarizing the patient's condition according to a map drawn by the doctor during previous visits (summary). The CDSS system calculates the stage of the disease based on specific parameters. When entering the results of the tests, the system calculates the stage of the disease and automatically shows the appropriate

treatment protocols for each stage from the stages of the disease and arranged according to the most used, which helps reduce medical errors.

The CDSS system also obeys predictions about the most used treatment by counting the number of previous cases used for the treatment protocol and its success rate. In addition to statistical reports extracted from the clinical decision support system, it helps study the causes of the disease and its treatment methods through the detailed characteristics of the disease in the system. Any doctor can follow a patient's condition undergoing treatment by another oncologist, as the system enables you to understand the stage that he has reached. The proposed clinical decision support system provides functions and services related to disease details, treatment plan, and organization of work procedures (along with WORKFLOW) from the beginning of the diagnosis process to completion of the diagnosis.

In addition, it organizes and arranges the programming of treatment sessions for each chemotherapy protocol and calculates the therapeutic doses for each drug according to internationally approved scientific equations while providing alerts that help the doctor to avoid making any mistakes, which explains the very high success rate of the system (CDSS). While the result (4.6667) for the mean of the advantage mentioned that the system provides the oncologist with all the scientific, medical sources, and references needed in determining the stage, diagnosis, and treatment. The reason for that result was that one of the oncologists made it clear that it is not necessary to use the global guidance reference (NCCN) and that the oncologist may resort to another reference or benefit from discussing specific disease cases with other experts about experimenting with a specific protocol mentioned in the global guidelines (NCCN). However, the oncologist stated that this system facilitates the discussion of cases such as (case study). In addition, the advantage that he talked about was the automatic arrangement of treatment protocols, which helps the oncologist to choose the most appropriate and optimal treatment.

The system (CDSS) proposes the optimal, accurate, correct, and convincing treatment for the oncologist after entering all the necessary diagnostic data. Also, the results of the analysis showed that the rate of these advantages (4.6667 ), which is a high rate certainly, but the reason for not reaching the rate to ( 5 ) was from the viewpoint of some experts that the system proposes many appropriate diagnoses for the case, but the final decision is left to the oncologist in the clinic due to the complexity of some cases despite their similarities, but some patients cannot bear the treatment of chemotherapy due to a general weakness in their bodies or the presence of other chronic diseases such as heart disease or kidney failure. This is in total agreement with the research done by (Suwanvecho et al. (2020)), which claimed that treatment should be up to the oncologist and depending on a particular patient's case. as shown in statistical table (4.2)

**Table # 2: Means and Standard Deviations of CDSS Advantages**

Statements	N	Mean	Std. Deviation
Does the Clinical Decision Support System (CDSS) provide the health care provider with timely, at the point of care, information to help make decisions about patient care?	6	5.0000	.00000
Does the system provide the physician with all the scientific and medical sources and references he needs in determining the stage, diagnosis, and treatment?	6	4.6667	.51640
Does the established clinical decision support system adopt global evidence-based guidelines? NCCN Guideline	6	5.0000	.00000
After you have used the clinical decision support system, does the system facilitate the process of referring to medical information easily, quickly, and in an organized way for each patient?	6	5.0000	.00000
After you use the modern clinical decision support system, does the system contain a screen that summarizes the patient's condition according to a map drawn by the physician during	6	5.0000	.00000

previous visits (Summary) to facilitate access to import			
Does the clinical decision support system calculate the stage of the disease based on certain determinants(Parameters), which are Pathology tests, that is, when the results of the tests are entered, the system calculates the stage of the disease and it	6	5.0000	.00000
Were the results of the diagnosis linked to the treatment likely to be used (by filtering treatment options based on the stage of the disease) so that the optimal treatment protocols appear specifically, with the details of each protocol mentioned in acco	6	4.8333	.40825
Are the therapeutic protocols that appear at each stage of the disease shown by the system, arranged according to the most used?	6	4.8333	.40825
If the answer to the previous question is yes? Does the automatic arrangement of therapeutic protocols help the physician to choose the most appropriate and optimal treatment?	6	4.6667	.51640
Does the system suggest optimal, accurate, correct, and convincing treatment for the doctor after entering all the necessary diagnostic data?	6	4.6667	.51640
Do you think that linking the results of diagnostic tests to treatment helps reduce medical errors?	6	5.0000	.00000
Does the system give predictions about the most used treatment through the number of previous cases used for the treatment protocol and its success rate?	6	4.8333	.40825
Do you think that the statistical reports that will be extracted from the clinical decision support system will be useful to study the causes of the disease and ways to treat it through the detailed characteristics of the disease in the system and through	6	4.6667	.51640
Did the new clinical decision support system provide accurate and specialized statistics on the disease (breast cancer)?	6	4.6667	.51640
Do you think that the statistical reports that will be extracted from the clinical decision support system will be useful to study the causes of the disease and ways to treat it through the detailed	6	5.0000	.00000

characteristics of the disease in the system and through			
If a patient with a previous medical history visits you in the clinical decision support system and is followed up by another oncologist, can you understand what stage he reached and the type of previous treatments he received easily and quickly without r	6	5.0000	.00000
Does the proposed clinical decision support system provide the functions and services related to the disease details and treatment plan that you expected from it?	6	5.0000	.00000
Does CDSS organize work procedures (combined with WORK FLOW) from the beginning of the diagnosis process until the completion of the diagnosis?	6	5.0000	.00000
Does the proposed system organize and arrange the programming of treatment sessions for each treatment protocol?	6	5.0000	.00000
Does the proposed system calculate the treatment doses for each drug according to internationally approved scientific equations?	6	5.0000	.00000
Does the process of calculating approved drug doses in the new clinical decision support system help the pharmacist responsible for analyzing and preparing drug doses?	6	5.0000	.00000
Does the process of calculating the doses of drugs included in the clinical decision support system help the nurse in the day care department who implements the treatment sessions?	6	5.0000	.00000
Did the smart system (Clinical Decision Support System) save time for the clinician?	6	5.0000	.00000
Did the proposed system allow the doctor to spend more time with his patient?	6	4.8333	.40825
Does the Clinical Decision Support System (CDSS) provide alerts that help the clinician avoid making any mistakes?	6	5.0000	.00000
Was the training mechanism easy and fast (easy to use the system) by the specialist or even the resident doctor?	6	5.0000	.00000
<b>Total Degree</b>	<b>6</b>	<b>4.9103</b>	<b>0.1621</b>

Table (4.2): Statistical Analysis: Means and Standard Deviations of CDSS Advantages

The consequences of disadvantages of conventional Health Information System (HIS).Table (4.3) shows the rate) mean)of unavailability of treatment guidelines, to assist the clinician in selecting the optimal treatment, and the lack of important information or references for diagnosis and treatment to be made available to the Avicenna system. The mean is equivalent to (5), which is a high rate in evaluating the negatives of the previous system compared to the availability of these important advantages in the proposed system (CDSS).

We noticed that some of standard deviation is zero (0), that is because the answers of the interviewed oncologists were the same.

**Table:# 4.3: Means & Standard Deviations of Previous System Disadvantages**

<b>Statements</b>	<b>N</b>	<b>Mean</b>	<b>Std. Deviation</b>
Is there a lack of important information or references for the diagnosis and treatment to be provided to patients with the Health information System-HIS (Avicenna)?	6	5.0000	.00000
Did the traditional system (Health information System-HIS) provide any treatment guidelines to help the doctor choose the optimal treatment?	6	1.3333	.51640
Do you think that the traditional method used so far (the computerized health system currently in use) is more difficult than the instructions in the expert system (the clinical decision support system)?	6	5.0000	.00000
Did the traditional system (the computerized health system in use today) provide the feature of calculating drug doses for the doctor and pharmacist previously?	6	1.3333	.51640
<b>Total Degree</b>	<b>6</b>	<b>3.1666</b>	<b>0.2582</b>

Table (4.3): Statistical Analysis:Means & Standard Deviations of Previous System Disadvantages

## Chapter Five: Discussion

### 5.1 Introduction

This chapter of the study explains the results of evaluating the CDSS system announced in this research and answering the questions of the study mentioned in the introduction, in addition to listing a comparison between the clinical decision support system and the health information system currently adopted in Palestinian government hospitals.

### 5.2 Discussion Of Results

Our CDSS system was made for breast cancer since it is the most prevalent in Palestine. Certainly, it can be used for other types of cancers such as colorectal cancers (Suwanvecho et al., 2020), and gastric and esophageal cancer (Somasekhar et al., 2018). In another study carried out by Klarenbeek et al., (2020), their results showed that huge enhancements of more significant level CDSSs on process results and rule adherence across assorted settings in oncology, and this is in accordance with our results.

After completing the creation of a clinical decision support system, testing it, and training oncologists in governmental hospitals, the researcher evaluated that expert system for breast cancer. Achieving the objectives of the study mentioned in the introduction to this study, as well as answering the research questions and hypotheses placed in the introduction to this study as well, which focused on the possibility of the clinical decision support system to meet the needs of oncologists, such as extracting accurate measurements about the types of treatment methods used and patient outcomes after applying each agreement (Therapeutic protocol), and improving the quality of health care service such as, saving time, effort and ease of use, as well as developing a smart system that achieves clear results compared to the health information system used in the Palestinian Ministry of Health, after reviewing the results of the expert system evaluation (CDSS), we can see that it achieved results higher than the level mentioned in the hypothesis, and research

questions. The oncologist confirmed that it saved more time, by allocating fields and dependent parameters, for breast cancer disease, all they have to do is to fill in these fields with the results of the required tests.

The CDSS system will automatically deduce the stage of the disease and then link the diagnosis to treatment by proposing filtered treatment agreements according to the most used and most successful, according to international guidelines, in addition to arranging and organizing medical data entry easily. Not only that, but the system retrieves the entered medical data by creating a detailed report on the patient's condition that tells the patient's story, from the date of injury (the first visit) until the last visit. Many ideas emerged by studying the needs of the oncologist to help diagnose and treating the disease, and facilitating the provision of treatment by scheduling the sessions for chemotherapy according to the global guidelines (NCCN ) that appear in front of them on the screen and integrated within the system (CDSS ).

The Clinical Decision Support System (CDSS) was emphasized to achieve all the advantages and functions mentioned in the literature studies which were also evaluated by analyzing the results of the interviews. We want to discuss how our proposed system avoided the flaws and faced the challenges pointed out in previous studies, including the division of tasks according to a harmonic flowchart. The oncologist has to work according to it, which may cause inconvenience, but in this system proposed in our current study, we overcame this challenge by following the flowchart desired by the oncologist. With the stages of diagnosis and treatment of breast cancer, the challenge of many alerts may bother the oncologist and may force him to close them without paying attention to reading them. The designer of the proposed system (CDSS) focused on placing the alerts box as a separate screen, next to all screens, and not placing a large number of alerts, by focusing on the most important warnings needed, to order medications.

In an attempt to summarize the entire results related to the mechanism of raising the level and quality of provided services by using the proposed program, from the researcher's point of view, this system saved the level of service from three aspects. The first aspect is saving time by saving time for case studies to make a decision. The second aspect is helping doctors use the data extracted from the new system to make predictive studies about the most effective treatments. Thanks to the proposed new system, it has become possible, and it is even straightforward. Finally, the third aspect is to reduce the incidence of error by filtering specific treatment options for each stage and helping the doctor follow the treatment protocols.

All oncologists might have made the mistake of reading the medical history before, especially when referring the patient to a treatment protocol and changing the type of medicines. As the oncologist who implements the protocol for the patient is another doctor in the daily care department, he reviews the doctor's last consultation, as it contained the previously canceled protocol. While regarding the clinical decision support system, it shows the last point of treatment that the patient arrived at, and it is impossible to make an error in calculating drug doses or session dates and types of drugs, as this system calculates the doses automatically.

The researcher suggested smart ideas, that she can provide to the oncologist to help him diagnose and treat patients, she chose breast cancer because it is the most complex, important, and widespread in Palestinian society. After designing a database, that is interconnected with information and includes knowledge bases for breast cancer, the researcher, with the help of a computer programmer, designed the user interface according to the sequence of the workflow diagram, in the oncology clinic and the daycare department, that implements the treatment protocol chosen by the specialist.

All the details about the patient is saved and protected by CDSS since no body can use the system except the oncologists because they have to login with a password to the system. Nurses in the day care department which is responsible for administering the chemotherapy protocols, have a specific

screen on the system to login with a password. They have no access to the oncologists to data entry screens .

### **5.3 Comparison Between Current Health Information System And CDSS System**

We mentioned in the introduction to this study, that physicians in governmental hospitals use a computerized health system that is not linked to scientific references, as it allows the doctor to enter information about disease cases in the clinic only. This system which is called Avicenna does not provide the advantages that are currently available in the clinical decision support system (CDSS). In addition to the evaluation of the defects of the previous system by specialists, to prove the lack of the required advantages in the previous system applied, in governmental hospitals. The fact the previous system does not provide specific fields for cancer parameters such as laboratory and radiological examinations, which do not link the results of examinations to treatment and do not suggest a treatment. Interviews with oncologists, who used the old system, and were trained on the proposed system CDSS, have a disadvantage in that the health system currently used in governmental hospitals does not provide detailed statistics about any disease, especially cancer.

Comparing the proposed program with the previous one in terms of follow-up and monitoring the patient's case is that the proposed program allows oncologists to follow up the case since the current procedures are taken toward treatment. In other words, the previous system is just a documentary system, which leads the oncologist to review the overall paper file of the patient to continue treatment. While the proposed program is not confined only to the documentation work of the patient, it helps the oncologists in the treatment of Breast cancer since the oncologists do not have to review all the files of the patient. The proposed system allows the doctor to read the latest treatment and depend on the treatment suggested by the program based on the medical protocols.

### 5.3.1 Comparison Between CDSS, And The Avicenna System

Due to the availability of large differences between the previous health information system used in governmental hospitals and the proposed expert system (CDSS), we summarize these differences in the table (5.1):

Subject	Avicenna System in MOH Hospitals	CDSS System for breast cancer
<b>Parameters for the characteristics of the disease</b>	Avicenna system does not provide parameter fields for any specific disease, as fields are used for patients with internal diseases, surgery, heart diseases, neurology, tumors, and others. They are fields with general names such as the field of documentation of visits, the field of notes of vital signs, and the field of diagnostic requests. Data is entered in the form of free text, hard to search for, in the future.	Provides parameter fields for the characteristics of the disease that can be counted and measurable. Data for the disease is entered in these distinct fields, such as, (Her2, TNM, Stage, ER, PR), and fields for treatment protocols for each stage of the disease
<b>Database and screens</b>	Database and screens are not interactive, and the fields are not related to each other. Data is entered separately, in each field. The physician continues to search for the appropriate treatment, in books and sites outside the system, and then enters the treatment protocol in a free text form, where it is difficult to review the entered information in the future, It is possible to search all previous visits of the patient, to know the patient's medical history.	Database and screens are interactive, and the fields simulate each other. When the results of the tests are entered into the specified parameter fields, the CDSS deduces the pathological stage and proposes the appropriate treatment protocols for that stage. It also presents the percentage of use for each treatment protocol and arranges them according to the highest percentage of use.
<b>Follow up of patients' visits to</b>	At every visit to the patient, the physician has to read many of the previous visits, and the patient's history, to remember what treatment stage the patient is currently in.	The stages of treatment are followed in the order in (CDSS), as the system does not accept the description of treatment, before

<b>the oncologists</b>		the completion of the stage of conducting the necessary examinations, diagnosis, follow-up phase, and periodic re-diagnosis).
<b>Statistical reports</b>	It is not possible to extract accurate statistical reports, according to the stage of the disease or the type of treatment, that was used for each stage, nor, even, the results of the treatment given to the patient, whether positive results such as the patient's improvement. The number of years of life after treatment or the stabilization of the condition, or negative indicating the deterioration of the patient's health condition due to treatment or until the death of the patient. It can be clear that there are no statistics except about the number of patients with this disease.	CDSS can give us accurate statistics, about the number of patients from each stage of the disease, what protocol was used (the most used protocol for each stage), and statistics about the patient's condition after completion of the treatment. It is considered an evaluation of the medications; did the patient improve or relapse?
<b>Study of risk factors of the disease</b>	Researchers cannot obtain information about the risks of the disease, because there is no parameter field to enter data related to the risks of the disease, and the physicians do not fill in such important data, and, even, if the oncologist asks the patient about this information, he enters it into the system through the visit field as a free text. It is difficult to refer to all visits of patients to obtain important information, regarding the risks of the disease.	It is possible to benefit from (CDSS), by evaluating the potential risks of the disease, by designing a screen called (risk questionnaire). This screen contains the most important parameters, for evaluating the risks of the disease, such as smoking, medical history, chronic diseases, and obesity.
<b>Programming,</b>	The information system does not provide the feature of programming, arranging, and organizing therapeutic sessions	The proposed expert system provides the feature of programming, arranging, and

<p><b>arranging, and organizing treatment sessions</b></p>	<p>(chemotherapy protocols).The oncologist is forced to explain and write his notes about the sessions in detail, to be read by the resident doctor, pharmacist, and nurse who will carry out the session. As for the schedule and dates of subsequent sessions, the patient is asked to write the date of each session on a card without knowing how many subsequent sessions he will have.</p>	<p>organizing treatment sessions (Chemotherapy protocols).The oncologist can program subsequent sessions, details which appear automatically, written within the screen (Treatment Plan) that we talked about earlier, and can print the appointment card for the sessions, and give it to the patient.In addition to that, it is easy for the resident doctor, the pharmacist, and the nurse to carry out the session, with ease and accuracy without mistakes.</p>
<p><b>Artificial intelligence tool</b></p>	<p>No artificial intelligence tool is available, such as deducing (calculating) the stage of the disease based on the parameters of laboratory tests, not, even, calculating drug doses based on specialized equations such as return (Body Surface Area).</p>	<p>Artificial intelligence tool is available, such as deducing (calculating) the stage of the disease based on the parameters of laboratory tests, not, even, calculating drug doses based on specialized equations such as return (Body Surface Area).</p>

Table (5.1): Comparison between CDSS, and the Avicenna system

## Chapter Six: Conclusions and Recommendations

### 6.1 Introduction

In this chapter, we will talk about benefits, strengths, and recommendations. We will talk about future works, research and study limitations.

### 6.2 Conclusions

CDSS has been appeared to increase medical care suppliers in an assortment of decisions and patient care assignments, and today they effectively and pervasively support the conveyance of quality care. A few utilizations of CDSS have more proof behind them, particularly those dependent on CPOE. Backing for CDSS keeps on mounting in the age of the electronic medical record, and there are even more advances to be made including interoperability, speed and simplicity of arrangement, and inexpensiveness. Simultaneously, we should remain cautious for the likely collapse of CDSS, which range from just not working and squandering assets, to exhausting suppliers and compromising the quality of patient care. Additional insurances and scrupulous plans should be taken when constructing, carrying out, and looking after CDSS. A segment of these contemplations was shrouded in this review, yet further review will be needed practically speaking, particularly as CDSS keeps on developing in intricacy through propels in AI, interoperability, and new sources of information.

Our results prove that higher level CDSSs appear to develop the process further, results, rules adherence, and clinical outcomes. Our results also supported the notion that the CDSS reduces clinical errors made by oncologists and cancer specialists. Ours is the first intelligent program that can assist oncologists in detecting and treating breast cancer at various stages. Furthermore, our program is the first to be utilized in Palestine, and there are no other tools that provide precise information and assistance to breast cancer specialists. With some additional programming, our method can potentially treat different cancer types.

### 6.2.1 Strengths Of The Study

- Using an essential artificial intelligence tool in one of the most essential and dangerous cancerous diseases aims to reduce medical errors, develop treatment methods, and improve the level of case studies through health data extracted from the clinical decision support system (CDSS) in an orderly and orderly manner.
- No one has previously used a CDSS to facilitate the diagnosis and treatment of breast cancer in the Arab world and even in the Western world.
- Health information systems are often used to document patient data and the treatment provided to the patient in the health institution. Never before has a health information system devised a method for evaluating a treatment protocol after its completion, and no one has discussed the idea of evaluating a treatment protocol and allocating special fields to write the reasons for giving treatment, or reasons for stopping treatment, in a manner, It is easy to count and study.
- Never before has a health information system linked diagnostic tests with scientific medical information and global guidelines so that the treatment is proposed before the physician's eyes. He does not have to refer to books and scientific references to choose the appropriate treatment, except in exceptional cases that may require physicians to meet and study the case. This CDSS system is designed to make it easier to retrieve information entered in an ordered and systematic manner to support case studies.
- Never before has a health information system calculated the number of cases that used each protocol, and shown next to each protocol the number of previous cases with which that protocol was used, its success rate after its completion and evaluation, which gives the oncologist predictions of the most successful, effective and most widely used protocol.
- No health information system has ever given an automatic detailed, organized, and sorted incrementally according to date report about the patient's condition from the beginning of the

disease until the date of the last visit, by collecting the data entered for the patient from more than one screen, this report was named (patient's story) as if it was telling the reader a story Patient with medical information in an orderly and organized manner.

- CDSS allows the oncologist to develop a treatment plan for the way drugs are given. For example, if the protocol contains three drugs, it must be divided into four sessions. These four sessions quickly and the division of drugs with specific mixtures, every two types of drugs in a separate session, allow the oncologist who follows the patient's condition in the future to understand the mechanism of drug administration in previous sessions easily.
- One of the disadvantages of the health information system is that it prevents the physician from spending more time with the patient, and according to the intangible practices of health care providers, they spend most of their time entering data, diagnosing, and treating the patient through the electronic health record rather than spending more time with the patient. As a result, the examination has become more time-consuming. Clinical is scarce after doctors spend most of their time on the computer screen following up on the patient's tests and treatment, but the proposed system (CDSS) freed up much time for the doctor to spend with the patient.

### **6.3 Recommendations**

This study discussed creating a clinical decision support system (CDSS), an expert system with a specific disease. The focus was on breast cancer, integrating scientific (medical) knowledge and modern technology (artificial intelligence). Breast cancer was specifically chosen because it is the most complex and the rate of survival from it is higher than other types of cancer; according to the practical experience during entering medical data for 95 patients with breast cancer within the proposed system (CDSS), most of the cases started the history of breast cancer more than 7 years ago. During the interviews to evaluate the proposed system CDSS, The Oncologists requested that other types of cancer be included in this system. The researcher hopes to develop this system by :

1. Adding more types of cancer in the future, such as colon cancer, lung cancer, liver cancer, prostate cancer, etc.
2. To utilize our system in governmental and nongovernmental hospitals, clinics, and health care centers.
3. To carry on with training sessions for all oncologists on how to use our CDSS.
4. To adopt our CDSS by the Palestinian Ministry of Health, Palestinian Statistical Bureau, other Ministries, and other organizations.
5. To use our CDSS in research and other studies about different types of cancer.

#### **6.4 Further Work**

In the future, if sufficient data can be secured through cooperation among multiple organizations, more reliable results can be obtained. Additionally, to investigate the effect of more significant level CDSSs on the nature of care, great studies and researches are required. Our program could be developed to be used with other types of cancers to help oncologists in the diagnosis and treatment of different types of cancer in Palestine.

#### **6.5 Study Limitations**

- Due to her dual role as a programmer and researcher (a university student), the researcher experienced time constraints, as her study took more than a year to complete, particularly the practical or experimental portion.
- Lack of time and workload did not allow oncologists to enter more disease cases into the clinical decision support system, in this short time.
- The majority of oncologists said that the proposed system did not cover all types of cancer, according to qualitative data gathered through interviews with them. We plan to include the remaining cancer kinds in the CDSS in the future.

## REFERENCES

- Ghoncheh, M., Pournamdar, Z., & Salehiniya, H. (2016). Incidence and mortality and epidemiology of breast cancer in the world. *Asian Pacific Journal of Cancer Prevention*, 17(S3), 43-46.
- Osheroff, J. 2012. Improving Outcomes with Clinical Decision Support: An Implementer's
- Bright, T. J., Wong, A., Dhurjati, R., Bristow, E., Bastian, L., Coeytaux, R. R., ... & Lobach, D. (2012). Effect of clinical decision-support systems: a systematic review. *Annals of internal medicine*, 157(1), 29-43.
- De Placido, S., De Angelis, C., Giuliano, M., Pizzi, C., Ruocco, R., Perrone, V., ... & Arpino, G. (2017). Imaging tests in staging and surveillance of non-metastatic breast cancer: changes in routine clinical practice and cost implications. *British Journal of Cancer*, 116(6), 821-827.
- Singletary, S. E., Allred, C., Ashley, P., Bassett, L. W., Berry, D., Bland, K. I., ... & Greene, F. L. (2002). Revision of the American Joint Committee on Cancer staging system for breast cancer. *Journal of clinical oncology*, 20(17), 3628-3636.
- Kawamoto, K., Houlihan, C. A., Balas, E. A., & Lobach, D. F. (2005). Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to success. *Bmj*, 330(7494), 765.
- World Health Organization. (2013). International classification of diseases for oncology (ICD-O)—3rd edition, 1st revision.
- Prado, C. M., Baracos, V. E., McCargar, L. J., Reiman, T., Mourtzakis, M., Tonkin, K., ... & Sawyer, M. B. (2009). Sarcopenia as a determinant of chemotherapy toxicity and time to tumor progression in metastatic breast cancer patients receiving capecitabine treatment. *Clinical cancer research*, 15(8), 2920-2926.
- Deepamalar, M. Artificial Intelligence Based Semantic Web Decision Support System for Health Care Big Data, 2021.

- Patkar, V., Acosta, D., Davidson, T., Jones, A., Fox, J., & Keshtgar, M. (2011). Cancer multidisciplinary team meetings: evidence, challenges, and the role of clinical decision support technology. *International journal of breast cancer*, 2011.
- Sartipi, K., Archer, N. P., & Yarmand, M. H. (2011). Challenges in developing effective clinical decision support systems. *Efficient Decision Support Systems—Practice and Challenges in Biomedical Related Domain*.
- Coiera, E. Guide to Health Informatics, 2nd ed.; CRC Press: Boca Raton, FL, USA, 2003.
- Bright, T.J.; Wong, A.; Dhurjati, R.; Bristow, E.; Bastian, L.; Coeytaux, R.R.; Samsa, G.; Hasselblad, V.; Williams, J.W.; Musty, M.D.; et al. Effect of clinical decision-support systems: A systematic review. *Ann.Intern. Med.* **2012**, 157, 29–43.
- Mollon, B.; Chong, J.J.; Holbrook, A.M.; Sung, M.; Thabane, L.; Foster, G. Features predicting the success of computerized decision support for prescribing: A systematic review of randomized controlled trials. *BMC Med. Inform. Decis. Mak.* **2009**, 9, 1–9.
- Piccart-Gebhart, M.J.; Sotiriou, C. Adjuvant chemotherapy—Yes or no? Prognostic markers in early breast cancer. *Ann. Oncol.* **2007**, 18, 2–7.
- Marcial, L.H.; Richardson, J.E.; Lasater, B.; Middleton, B.; Osheroff, J.A.; Kawamoto, K.; Blumenfeld, B.H. The Imperative for Patient-Centered Clinical Decision Support. *EGEMs (Generating Evid. Methods Improv. Patient Outcomes)* **2018**, 6, 1–8.
- Mazo, Claudia, Cathriona Kearns, Catherine Mooney, and William M. Gallagher, 2020. Clinical Decision Support Systems in Breast Cancer: A Systematic Review. *Cancers*, 12, 369.
- Shahsavarani, A.M.; Abadi, E.A.M.; Kalkhoran, M.H.; Jafari, S.; Qaranli, S. Clinical Decision Support Systems (CDSSs): State of the art Review of Literature. *Int. J. Med. Rev.* **2015**, 2, 299–308.
- Community Preventive Services Task Force; Njie, G.; Proia, K.; Thota, A.; Finnie, R.; Hopkins, D.; Banks, S.; Callahan, D.; Pronk, N.; Rask, K.; et al. Clinical Decision Support Systems and Prevention: A Community Guide Cardiovascular Disease Systematic Review. *Am. J. Prev. Med.* **2015**, 49, 784–795.
- Fathima, M.; Peiris, D.; Naik-Panvelkar, P.; Saini, B.; Armour, C.L. Effectiveness of computerized clinical decision support systems for asthma and chronic obstructive pulmonary disease in primary care: A systematic review. *BMC Pulm. Med.* **2014**, 14, 189.

- Schaarup, C.; Pape-Haugaard, L.B.; Hejlesen, O.K. Models Used in Clinical Decision Support Systems Supporting Healthcare Professionals Treating Chronic Wounds: Systematic Literature Review. *JMIR Diabetes* **2018**, 3, e11.
- Hemens, B.J.; Holbrook, A.; Tonkin, M.; Mackay, J.A.; Weise-Kelly, L.; Navarro, T.; Wilczynski, N.L.; Haynes, R.B.; CCDSS Systematic Review Team Computerized clinical decision support systems for drug prescribing and management: A decision-maker-researcher partnership systematic review. *Implement. Sci.* **2011**, 6, 89.
- Van Wijk, Y.; Halilaj, I.; van Limbergen, E.; Walsh, S.; Lutgens, L.; Lambin, P.; Vanneste, B.G.L. Decision Support Systems in Prostate Cancer Treatment: An Overview. *BioMed Res. Int.* **2019**, 2019, 1–10.
- Jia, P.; Zhang, L.; Chen, J.; Zhao, P.; Zhang, M. The Effects of Clinical Decision Support Systems on Medication Safety: An Overview. *PLoS ONE* **2016**, 11, 1–17.
- Kawamoto, K.; Lobach, D.F. Clinical decision support provided within physician order entry systems: A systematic review of features effective for changing clinician behavior. *AMIA Annu. Symp. Proc.* **2003**, 2003, 361.
- Jao, C.S.; Hier, D.B. Clinical Decision Support Systems: An Effective Pathway to Reduce Medical Errors and Improve Patient Safety. In *Decision Support Systems*; Jao, C.S., Ed.; IntechOpen: Rijeka, Croatia, 2010; Chapter 8.
- Séroussi, B.; Bouaud, J. Using OncoDoc as a computer-based eligibility screening system to improve accrual onto breast cancer clinical trials. *Artif. Intell. Med.* **2003**, 29, 153–167.
- Cancer-Its various types along with causes, symptoms, treatments and stages, in: cancer info guide. 2009. <http://www.cancer-info-guide.com/>.
- Mieszkowski M. R., 2006. Cancer – A biophysicist's point of view. In: *Digital Recordings*. 2006. <http://www.digital-recordings.com/publ/cancer.html> .
- Helmberg A. 2010. [17 Mar. 2010]. <http://helmberg.at/carcinogenesis.htm> .
- Diet and Physical Activity: What's the Cancer Connection? In: *Prevention & Early Detection*. 2009. [http://www.cancer.org/docroot/PED/content/PED\\_3\\_1x\\_Link\\_Between\\_Lifestyle\\_and\\_CancerMarch03.asp](http://www.cancer.org/docroot/PED/content/PED_3_1x_Link_Between_Lifestyle_and_CancerMarch03.asp) .
- Margot New SEER, 2007. Report Documents High Risk of Second Cancers in Cancer Survivors. *Oncology Times*. 29 (5):8.

- Ershler W.B., 2005. The Influence of Advanced Age on Cancer Occurrence and Growth. In: Balducci L., Extermann M, editors. *Biological Basis of Geriatric Oncology*. Vol. 124. Springer US: pp. 75–87
- Khuwaja G. A., Abu-Rezq A. N., 2004. Bimodal breast cancer classification system. *Pattern Analysis and application*. 7:235–242.
- Ganesh N. Sharma, Rahul Dave, JyotsanaSanadya, Piush Sharma, and K. K Sharma 2010. VARIOUS TYPES AND MANAGEMENT OF BREAST CANCER: AN OVERVIEW. *J Adv Pharm Technol Res*. 1(2):109-26.
- Breast cancer process India, Breast cancer cost india, Breast cancer, Delhi India. *Breast cancer information and resources*. 2010. Apr 13. <http://www.digfortheure.org/breast-cancer-process-india-breast-cancer-cost-india-breast-cancer-delhi-india.html> .
- What is breast cancer? Imaginis. 2008. <http://www.imaginis.com/breast-health/what-is-breast-cancer-2> .
- What is breast cancer? American cancer society. 2009. [http://www.cancer.org/docroot/CRI/content/CRI\\_2\\_4\\_1X\\_What\\_is\\_breast\\_cancer\\_5.asp](http://www.cancer.org/docroot/CRI/content/CRI_2_4_1X_What_is_breast_cancer_5.asp) .
- Breast cancer. Merck. 2008. <http://www.merck.com/mmhe/sec22/ch251/ch251f.html> .
- Types of breast cancer. Abviva. 2009. <http://abviva.com/1.html> .
- Stephan P., 2008. Mucinous (Colloid) Carcinoma of the breast. About.com Cancer. [http://breastcancer.about.com/od/types/p/mucinous\\_ca.htm](http://breastcancer.about.com/od/types/p/mucinous_ca.htm) .
- Hartmann L. C., Sellers T. A., Frost M. H., Frost M. H., Lingle W. L., Degnim A. C., Ghosh K., Vierkant R. A., Maloney S. D., Pankratz V. S., Hillman D. W., Suman V. J., Blake C., Tlsty T., Vachon C. M., 2005. Benign breast disease and the risk of breast cancer. *N Engl J Med*. 353:229–237.
- Breast cancer. E medicine health. 2010. [20 Mar 2010]. [http://www.emedicinehealth.com/breast\\_cancer/page2\\_em.htm](http://www.emedicinehealth.com/breast_cancer/page2_em.htm) .

- Fletcher S. W. Patient information: Risk factor for breast cancer. Up-To-Date. 2008. <http://www.utdol.com/patients/content/topic.do?topicKey=~ rZvVFHbEjbw> .
- Definite breast cancer risks. CancerHelp UK. 2008. <http://www.cancerhelp.org.uk/type/breast-cancer/about/risks/definite-breast-cancer-risks> .
- Stephan P. What you need to know about breast cancer symptoms. About.com: Breast cancer. 2007. Dec 06. [http://breastcancer.about.com/od/whatisbreastcancer/a/bc\\_symptoms.htm](http://breastcancer.about.com/od/whatisbreastcancer/a/bc_symptoms.htm) .
- Smith R. A., Cokkinides V., Brawley O. W., 2008. Cancer screening in the United States, *CA Cancer J Clin.* 58:161–179.
- Lippman M. E. Breast cancer. In: Fauci A. S., editor., 2008. *Harrison's Principles of Internal Medicine*. 17th ed. Library of Congress Cataloging in Publication Data.
- Stages of breast cancer, Breast cancer.org. 2010. <http://www.breastcancer.org/symptoms/diagnosis/staging.jsp> .
- Ganesh N. Sharma, Rahul Dave, JyotsanaSanadya, Piush Sharma, and K. K Sharma, 2010. VARIOUS TYPES AND MANAGEMENT OF BREAST CANCER: AN OVERVIEW. *J Adv Pharm Technol Res.* (2):109-26.
- "How Big Data Impacts Healthcare," 2013. [Online]. Available: <https://hbr.org/>. [Accessed June 2016].
- W. G. Gilroy, "Notre Dame News," 25 July 2013. [Online]. Available: <https://news.nd.edu/news/notre-dame-researchers-develop-system-that-uses-a-big-data-approach-to-personalized-health-care/>. [Accessed 2016].
- M. Allen and O. Pierce, "Medical Errors Are No. 3 Cause Of U.S Deaths, Researchers Say," Health News from NPR, 2016.

- U. S Food and Drug Administration, "Strategies to Reduce Medication Errors: Working to Improve Medication Safety," Agency for Healthcare Research and Quality, 2017.
- E. V. Murphy, 2014. "Clinical Decision Support: Effectiveness in Improving Quality Processes and Clinical Outcomes and Factors That May Influence Success," *The Journal of Biology and Medicine* ,vol. 87, no. 2, pp. 187-197.
- J. M. Castellano, I. M. Jiminez, R. Mozos , F. C. Asso, A. C. Gonzalez and A. G. Alberola, 2015. "Symmetrical Compression Distance for Arrhythmia Discrimination in Cloud-Based Big-Data Services," *IEEE Journal of Biomedical and Health Informatics*, vol. 19, no. 4, pp. 1253 - 1263.
- U. Reinhardt, 2008. "Why Does U.S. Health Care Cost So Much? (Part II: Indefensible Administrative Costs)," Physicians for a National Health Program, Chicago.
- P. L. Yong and R. S. Saunders, "The Healthcare Imperative: Lowering Costs and Improving Outcomes: Workshop Series Summary. Washington (DC)," National Academies Press (US), 2010. [Online].
- Yang and M. Grissinger, 2013. "Wrong-Patient Medication Errors: An Analysis of Event Reports in Pennsylvania and Strategies for," *Pennsylvania Patient Safety Advisory*, vol. 10, no. 2, pp. 41-49.
- G. Egger, J. Dixon , H. Meldrum , A. Binns, M. A. Cole, D. Ewald and J. A. Stevens, 2015. "Patients' and providers' satisfaction with shared medical appointments," *Australian Family Physician* ,vol. 44, no. 9, pp. 674-679.
- P. Huang , L. G. Zhu , L. J. Zhai, Y. F. Zhu, M. Yue , J. Su, J. Wang and H. T. Yang, 2015. "Hepatitis C infection and risk factors in the General Population: A Large Community Based Study in Eastern China," *Cambridge University Press*, vol. 143, no. 10, pp. 282-283.
- P. Johnston and M. Hume, 2015. "Exploring One Accord for the Business of Aged Care Industry: The CEO's Perspective," *Electronic Journal of Health Informatics*, vol. 9, no. 1.

- B. Rossi , 2015. "How Big Data is Beating Ebola," Information Age.
- S. Ram, W. Zhang, M. Williams and Y. Pengetnze, 2015. "Predicting Asthma-Related Emergency Department Visits Using Big Data," *IEEE Journal of Biomedical and Health Informatics*, vol. 19, no. 4, pp. 1216-1223.
- D. Olsen, M. Birkohlz, J. T. Gaensbauer, E. J. Asturias and J. K. Todd, 2015. "Analysis of the pediatric health information system database as a surveillance tool for travel-associated infectious diseases," *The American Journal of Tropical Medicine and Hygiene* ,vol. 92, no. 5, pp. 1067-1069.
- Vonbach, P., Dubied, A., Krähenbühl, S. & Beer, J. H., 2008. Prevalence of drug-drug interactions at hospital entry and during hospital stay of patients in internal medicine. *Eur. J. Intern. Med.* 19, 413–420.
- Helmons, P. J., Suijkerbuijk, B. O., NannanPanday, P. V. &Kosterink, J. G. W., 2015. Drugdruginteraction checking assisted by clinical decision support: a return on investment analysis. *J. Am. Med. Inf. Assoc. Jamia.* 22, 764–772.
- Koutkias, V. &Bouaud, J., 2018. Contributions from the 2017 Literature on Clinical Decision Support. *Yearb. Med. Inf.* 27, 122–128.
- Cornu, P., Phansalkar, S., Seger, D. L., Cho, I. &Pontefract, S., 2018. International Journal of Medical Informatics High-priority and low-priority drug – drug interactions in different international electronic health record systems: a comparative study. *Int. J. Med. Inf.* 111, 165–171.
- McEvoy, D. S., 2017. Variation in high-priority drug-drug interaction alerts across institutions and electronic health records. *J. Am. Med. Inf. Assoc.* 24, 331–338.
- Mahoney, C. D., Berard-Collins, C. M., Coleman, R., Amaral, J. F. & Cotter, C. M., 2007. Effects of an integrated clinical information system on medication safety in a multi-hospital setting. *Am. J. Health Syst. Pharm.* 64, 1969–1977.

- Peris-Lopez, P., Orfila, A., Mitrokotsa, A. & van der Lubbe, J. C. A., 2011. A comprehensive
- RFID solution to enhance inpatient medication safety. *Int. J. Med. Inf.* 80, 13–24.
- Levtzion-korach, O., 2010. Effect of bar-code technology on the safety of medication
- administration. *N. Engl. J. Med.* 362, 1698–1707.
- Van der Veen, W. et al, 2018. Association between workarounds and medication
- administration errors in bar-code-assisted medication administration in hospitals. *J. Am.*
- *Med. Inf. Assoc.* 25, 385–392.
- Eslami, S., 2012. Effects of two different levels of computerized decision support
- on blood glucose regulation in critically ill patients. *Int J. Med. Inf.* 81, 53–60 (2012).
- Jia, P., Zhang, L., Chen, J., Zhao, P. & Zhang, M., 2016. The effects of clinical decision
- support systems on medication safety: an overview. *PLoS ONE* 11, 1–17.
- Kwok, R., Dinh, M., Dinh, D. & Chu, M., 2009. Improving adherence to asthma clinical
- guidelines and discharge documentation from emergency departments: Implementation of a
- dynamic and integrated electronic decision support system. *Emerg. Med. Australas.* 21, 31–
- 37.
- Shortliffe, T., 2006. Medical thinking: what should we do? [http://www.openclinical.org/](http://www.openclinical.org/medicalThinking2006Summary2.html)
- [medicalThinking2006Summary2.html](http://www.openclinical.org/medicalThinking2006Summary2.html).
- Salem, H., 2018. A multicentre integration of a computer led follow up in surgical
- oncology is valid and safe. *BJU Int.* <https://doi.org/10.1111/bju.14157>.
- Embi, P. J., Jain, A., Clark, J. & Harris, C. M., 2005. Development of an electronic health
- record-based Clinical Trial Alert system to enhance recruitment at the point of care. *AMIA*
- *Annu. Symp. Proc.* 2005, 231–235.
- Calloway, S., Akilo, H. & Bierman, K., 2013. Impact of a clinical decision support system
- on pharmacy clinical interventions, documentation efforts, and costs. *Hosp. Pharm.* 48, 744–
- 752.

- Algaze, C. A. 2016. Use of a checklist and clinical decision support tool reduces laboratory use and improves cost. *Pediatrics* 137, e20143019.
- Pruszydlo, M. G., Walk-Fritz, S. U., Hoppe-Tichy, T., Kaltschmidt, J. & Haefeli, W. E., 2012.
- Development and evaluation of a computerised clinical decision support system for switching drugs at the interface between primary and tertiary care. *BMC Med. Inf. Decis. Mak.* 12, 1.
- Bell, C. M., Jalali, A. & Mensah, E., 2013. A decision support tool for using an ICD-10
- Anatomy graphic to address admission coding inaccuracies: a commentary. *Online J. Public Health Inform.* 5, 222.
- Haberman, S., 2009. Effect of clinical-decision support on documentation compliance
- in an electronic medical record. *Obstet. Gynecol.* 114, 311–317.
- McEvoy, D., Gandhi, T. K., Turchin, A. & Wright, A, 2017. Enhancing problem list documentation in electronic health records using two methods: the example of prior splenectomy. *BMJ QualSaf.* <https://doi.org/10.1136/bmjqs-2017-006707>.
- Berner E., 2016. *Clinical Decision Support Systems: Theory and Practice* 3rd edn. <https://doi.org/10.1007/978-0-387-38319-4>.
- Segal, M. M., 2017. Experience with integrating diagnostic decision support software with electronic health records: benefits versus risks of information sharing. *EGEMs Gener. Evid. Methods Improv. Patient Outcomes* 5, 23.
- Kunhimangalam, R., Ovallath, S. & Joseph, P. K. A clinical decision support system
- with an integrated EMR for diagnosis of peripheral neuropathy. *J. Med. Syst.* 38, 38 (2014).
- Martinez-Franco, A. I, 2018. Diagnostic accuracy in Family Medicine residents
- using a clinical decision support system (DXplain): a randomized-controlled trial.
- *Diagn. Berl. Ger.* 5, 71–76.

- Singh, H., Schiff, G. D., Graber, M. L., Onakpoya, I. & Thompson, M. J., 2017. The global burden of diagnostic errors in primary care. *BMJ Qual. Saf.* 26, 484–494.
- Razzaki, S, 2018. A comparative study of artificial intelligence and human doctors for the purpose of triage and diagnosis. arXivpreprint arXiv:1806.10698.
- Blackmore, C. C., Mecklenburg, R. S. & Kaplan, G. S, 2019.. Effectiveness of clinical decision support in controlling inappropriate imaging. *JACR* 8, 19–25.
- DSS Inc. Radiology Decision Support (RadWise®). <https://www.dssinc.com/products/integrated-clinical-products/radwise-radiology-decision-support/>.
- Giardino, A., 2017. Role of imaging in the era of precision medicine. *Acad. Radiol.* 24, 639–649.
- From Invisible to Visible: IBM Demos AI to Radiologists. Accessed Aug 2019 (2016).
- Suzuki, K. & Chen, Y, 2018. Artificial intelligence in decision support systems for diagnosis in medical imaging.
- Gulshan, V., 2016. Development and validation of a deep learning algorithm for detection of diabetic retinopathy in retinal fundus photographs. *JAMA - J. Am. Med. Assoc.* 316, 2402–2410.
- Hannun, A. Y., 2019. FOCUS | Letters FOCUS | Letters Cardiologist-level arrhythmia detection and classification in ambulatory electrocardiograms using a deep neural network letters FOCUS letters | FOCUS. *Nat. Med.*
- Erickson, B. J., 2016. *Machine Intelligence in Medical Imaging* (Society for Imaging Informatics, SIIM).
- Mørkrid, L., 2015. Continuous age- and sex-adjusted reference intervals of urinary markers for cerebral creatine deficiency syndromes: a novel approach to the definition of reference intervals. *Clin. Chem.* 61, 760–768.

- Davis, S., Roudsari, A., Raworth, R., Courtney, K. L. & Mackay, L., 2017. Shared decision making using personal health record technology: a scoping review at the crossroads. *J. Am. Med. Inf. Assoc.* 24, 857–866.
- Fuji, K. T., 2012. Standalone personal health records in the United States: meeting patient desires. *Health Technol.* 2, 197–205.
- Hanauer, D. A., Preib, R., Zheng, K. & Choi, S. W., 2014. Patient-initiated electronic health record amendment requests. *J. Am. Med. Inf. Assoc.* 21, 992–1000.
- Roehrs, A., Da Costa, C. A., Da Rosa Righi, R. & De Oliveira, K. S. F., 2017. Personal health records: A systematic literature review. *J. Med. Internet Res.*
- Kumar, R. B., Goren, N. D., Stark, D. E., Wall, D. P. & Longhurst, C. A., 2016. Automated integration of continuous glucose monitor data in the electronic health record using consumer technology. *J. Am. Med. Inf. Assoc.* 23, 532–537.
- Kilsdonk, E., Peute, L. W., Riezebos, R. J., Kremer, L. C. & Jaspers, M. W. M., 2016. Uncovering healthcare practitioners' information processing using the think aloud method: From paper-based guideline to clinical decision support system. *Int. J. Med. Inf.* 86, 10–19.
- Dowding, D., 2009. Nurses' use of computerised clinical decision support systems: A case site analysis. *J. Clin. Nurs.* 18, 1159–1167.
- Ash, J. S., Sittig, D. F., Campbell, E. M., Guappone, K. P. & Dykstra, R. H., 2007. Some unintended consequences of clinical decision support systems. *AMIA AnnuSymp. Proc. AMIA Symp.* AMIA Symp. 2007, 26–30.
- Khalifa, M. & Zabani, I., 2016. Improving utilization of clinical decision support systems by reducing alert fatigue: Strategies and recommendations. *Stud. Health Technol. Inform.* 226, 51–54.

- Van Laere, S., 2018. Clinical decision support systems for drug allergy checking: systematic review.
- Goddard, K., Roudsari, A. & Wyatt, J., 2011. Automation bias - A hidden issue for clinical decision support system use. *Stud. Health Technol. Inform.* 164, 17–22.
- Devaraj, S., Sharma, S. K., Fausto, D. J., Viernes, S. & Kharrazi, H., 2014. Barriers and facilitators to clinical decision support systems adoption: a systematic review. *J. Bus Adm. Res.*
- Cook, D. A., Teixeira, M. T., Heale, B. S. E., Cimino, J. J. & Del Fiol, G., 2017. Context sensitive decision support (infobuttons) in electronic health records: a systematic review. *J. Am. Med Inf. Assoc.* 24, 460–468.
- Index - FHIR v3.0.1. (2018). <https://www.hl7.org/fhir/index.html>. Accessed July 2019.
- European Commission Report. Commission Recommendation on a European Electronic Health Record Exchange Format (C(2019)800) of 6 February 2019. (2019).
- Bresnick, J., 2015. HealthITAnalytics. Interoperability, Low Costs Make Cloud-Based EHRs a Favorite..
- Rodrigues, J. J. P. C., de la Torre, I., Fernández, G. & López-Coronado, M., 2013. Analysis of the security and privacy requirements of cloud-based electronic health records systems. *J. Med. Internet Res.* 15, e186.
- Kabachinski, J., 2013. A look at clinical decision support systems. *Biomed. Instrum. Technol.* 47, 432–434.
- Jacob, V., 2017. Cost and economic benefit of clinical decision support systems (CDSS) for cardiovascular disease prevention: a community guide systematic review. *J. Am. Med. Inf. Assoc. Jamia.* 24, 669–676. (CRC Press, 2014).
- [https://www.nccn.org/login?ReturnURL=https://www.nccn.org/professionals/physician\\_gls/pdf/breast-screening.pdf](https://www.nccn.org/login?ReturnURL=https://www.nccn.org/professionals/physician_gls/pdf/breast-screening.pdf)

- Klarenbeek, Sosse E., Harm H.A. Weekenstroom, J.P. Michiel Sedelaar, Jurgen J. Fütterer, Mathias Prokop, and Marcia Tummers. The Effect of Higher Level Computerized Clinical Decision Support Systems on Oncology Care: A Systematic Review. *Cancers*, 2020 Apr; 12(4): 1032.
- Somashekhar SP, Sepúlveda MJ, Puglielli S, Norden AD, Shortliffe EH, Rohit Kumar C, Rauthan A, Arun Kumar N, Patil P, Rhee K, Ramya Y. Watson for Oncology and breast cancer treatment recommendations: agreement with an expert multidisciplinary tumor board. *Ann Oncol*. 2018 Feb 1;29(2):418-423. doi: 10.1093/annonc/mdx781.
- Suwanvecho, S., Suwanrusme, H., Jirakulaporn, T., Issarachai, S., Taechakraichana, N., Lungchukiet, P., ... & Kiatikajornthada, N. (2021). Comparison of an oncology clinical decision-support system's recommendations with actual treatment decisions. *Journal of the American Medical Informatics Association*, 28(4), 832-838.

## الملخص

يعد سرطان الثدي من أكثر أنواع السرطان شيوعاً. ومع ذلك ، فإنه يعتبر أكثر الأمراض قابلية للعلاج وإنقاذ الحياة ، خاصة عند إجراء الفحوصات المبكرة. معدلات الوفيات آخذة في الانخفاض نتيجة التشخيص المبكر والعلاج الأفضل. يحتاج أطباء الأورام إلى أدوات دقيقة للمساعدة في توجيه القرارات السريرية ، وتحسين بقاء المريض ، وتعزيز جودة الرعاية الصحية بشكل أفضل ، وتقليل أعباء المريض ، مثل التكاليف الباهظة والوقت والجهد ، بسبب التعقيد الطبي لسرطان الثدي ، ووقت الطبيب المحدود ، والحاجة إلى اتخاذ القرارات ، وبيئة صنع القرار القائمة على الأدلة.

في هذه الدراسة ، تم تطوير نظام دعم القرار السريري (CDSS) بسبب الحاجة المتزايدة لاتخاذ القرارات ، في مراحل مختلفة من رحلة المريض السريرية ، مثل التشخيص والعلاج والمراقبة ، لمساعدة أطباء الأورام في تحديد وتشخيص مراحل المرض واستنتاج واقتراح بروتوكولات العلاج الممكنة المناسبة. المرحلة التي تلي تصفية بروتوكولات العلاج الكيميائي والعلاج الهرموني بطريقة علمية مقترحة من قبل الدلائل الإرشادية المعتمدة دولياً (NCCN GUIDELINE) ، مما يجعل طبيب الأورام يعتمد على هذا البرنامج كمصدر واحد بدلاً من الإشارة إلى العديد من المصادر أو البرامج أو القواميس الطبية أو الإنترنت ، بحيث تكون مهمة أخصائي الأورام اختيار العلاج الأفضل للمريض وتقليل الخطأ الطبي.

بعد شهور وسنوات من استخدام هذا النظام ، قد يوفر خطة علاجية قادرة على إعطاء أفضل النتائج ، وترتيب هذه البروتوكولات حسب الأكثر استخداماً ونجاحاً ، لأن النظام يتضمن ميزة تقييم كل بروتوكول علاجي بعد الجلسات ، حيث وكذلك ترتيب وتنظيم المعلومات المدخلة في النظام بما في ذلك جميع الخصائص والمعلومات. المرض واسترجاعه آلياً من خلال تقرير آلي يظهر بترتيب تصاعدي يخبر تفاصيل المريض من الزيارة الأولى إلى الأخيرة. تم اختبار نظام دعم القرار السريري من خلال دخول 95 مريضاً وتدريب الأطباء على استخدامه في بيئة العمل في مستشفى بيت جالا الحكومي. بعد اعتماد النظام المقترح من قبل مؤسسة صحية متخصصة في السرطان في فلسطين ، أوصت الباحثة بتطوير النظام في المستقبل ليشمل جميع أنواع السرطانات. كما تأمل في تطبيقه في جميع مستشفيات وزارة الصحة الفلسطينية.

## Appendix: Questionnaire for Interviews



الجامعة العربية الأمريكية  
ARAB AMERICAN UNIVERSITY



**Health Informatics Master Program**

**Thesis**

**Questionnaire for Interview**

**Supervisor**

**Dr.Yussof Mimi & Prof.MohammedAwad**

**Prepared by**

**Asma'a Khalil**

**2022**

## Appendix

الاسئلة	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
<b>System feature questions (advantages CDSS)</b>					
Does the Clinical Decision Support System (CDSS) provide the health care provider with timely, at the point of care, information to help make decisions about patient care?					
Does the system provide the physician with all the scientific and medical sources and references he needs in determining the stage, diagnosis and treatment?					
Does the established clinical decision support system adopt global evidence-based guidelines? NCCN Guideline					
After you have used the clinical decision support system, does the system facilitate the process of referring to medical information easily, quickly, and in an organized way for each patient?					
After you use the modern clinical decision support system, does the system contain a screen that summarizes the patient's condition according to a map drawn by the physician during previous visits (Summary) for the purpose of facilitating access to important information?					
Does the clinical decision support system calculate the stage of the disease based on certain determinants(Parameters), which are Pathology tests, that is, when the results of the tests are entered, the system calculates the stage of the disease and it appears automatically?					
Were the results of the diagnosis linked to the treatment likely to be used (by filtering treatment options based on the stage of the disease) so that the optimal treatment protocols appear specifically, with the details of each protocol mentioned in accordance with international guidelines?					
Are the therapeutic protocols that appear at each stage of the disease shown by the system, arranged according to the most used?					
If the answer to the previous question is yes? Does the automatic arrangement of therapeutic protocols help the physician to choose the most appropriate and optimal treatment?					
Does the system suggest optimal, accurate, correct and convincing treatment for the doctor after entering all the necessary diagnostic data?					
Do you think that linking the results of diagnostic tests to treatment helps reduce medical errors?					
Does the system give predictions about the most used treatment through the number of previous cases used for the treatment protocol and its success rate?					
Do you think that the statistical reports that will be extracted from the clinical decision support system will be useful to study the causes of the disease and ways to treat it through the detailed characteristics of the disease in the system and through the development of an assessment and the result of the treatment after its completion?					

Did the new clinical decision support system provide accurate and specialized statistics on the disease (breast cancer)?					
Do you think that the statistical reports that will be extracted from the clinical decision support system will be useful to study the causes of the disease and ways to treat it through the detailed characteristics of the disease in the system and through the development of an assessment and the result of the treatment after its completion?					
If a patient with a previous medical history visits you in the clinical decision support system and is followed up by another oncologist, can you understand what stage he reached and the type of previous treatments he received easily and quickly without referring to the previous specialist?					
Does the proposed clinical decision support system provide the functions and services related to the disease details and treatment plan that you expected from it?					
Does CDSS organize work procedures (combined with WORK FLOW) from the beginning of the diagnosis process until the completion of the diagnosis?					
Does the proposed system organize and arrange the programming of treatment sessions for each treatment protocol?					
Does the proposed system calculate the treatment doses for each drug according to internationally approved scientific equations?					
Does the process of calculating approved drug doses in the new clinical decision support system help the pharmacist responsible for analyzing and preparing drug doses?					
Does the process of calculating the doses of drugs included in the clinical decision support system help the nurse in the day care department who implements the treatment sessions?					
Did the smart system (Clinical Decision Support System) save time for the clinician?					
Did the proposed system allow the doctor to spend more time with his patient?					
Does the Clinical Decision Support System (CDSS) provide alerts that help the clinician to avoid making any mistakes?					
Was the training mechanism easy and fast (easy to use the system) by the specialist or even the resident doctor ?					
<b>Weaknesses of the previous system (Avicenna Disadvantages)</b>					
Is there a lack of important information or references for the diagnosis and treatment to be provided to patients with the Health information System-HIS (Avicenna)?					
Did the traditional system (Health information System-HIS) provide any treatment guidelines to help the doctor choose the optimal treatment?					
Do you think that the traditional method used so far (the computerized health system currently in use) is more difficult than the instructions in the expert system (the clinical decision support system)?					
Did the traditional system (the computerized health system in use today) provide the feature of calculating drug doses for the doctor and pharmacist previously?					

**Open Questions:**

- 1- After you have used the proposed system (CDSS), what are the strengths and advantages provided by the system that did not exist previously?**
- 2- Explain how the system raised the level and quality of service provided to patients?**
- 3- Explain how the proposed clinical decision support system became useful (easier) for disease monitoring and follow-up?**