Promoting Awareness and Early Detection of Breast Cancer in Saudi Arabia

SELP 695: Systems Engineering Integrative Project

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Fall 2016
Dr. Arnold J. Galloway
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<td>Lessons Learned</td>
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Introduction to Breast Cancer
What is it and How Does it Form?

• “Breast cancer is an uncontrolled growth of breast cells.”

• Cancer cells proliferate, leading to an unhealthy process of cell growth.

• Breast cancer is a type of cancer based on the formation of a malignant tumor in the breast.

• Malignant (cancerous) cells accumulate to form tissue, known as a "lump", growth or tumor.
Stages of Breast Cancer

- Abnormal cells found in the breast milk duct
- Non-invasive
- Cells have not spread outside of the ducts or lobules

- Tumor measures up to 2 cm, or
- Small cancer cells groups measuring more than 0.2 millimeter
- Invasive breast cancer

- The tumor is between 2 and 5 cm
- Invasive breast cancer
- Extended to the nearby lymph node

- The tumor is larger than 5 cm
- Invasive breast cancer
- Invaded nearby lymph nodes and muscles
- Extended beyond immediate region of the tumor

- Invasive breast cancer
- Spread to nearby lymph nodes
- Spread to other organs of the body, such as the lungs, skin, bones, liver, or brain.
## Risk Factors

### Uncontrollable Risk Factors

- **Gender**
  - Being a woman is the biggest risk factor for developing breast cancer.

- **Age**
  - Breast Cancer risk goes up with age.
  - About 2 of 3 cases are found in women age 55 or older.

- **Family History**
  - Breast Cancer among close relatives greatly impact risk.

- **Race/Ethnicity**
  - Certain races have higher risk than others.

### Controllable Risk Factors

- **Weight**
  - Overweight and obese women have a higher risk of being diagnosed with breast cancer.

- **Habits**
  - Drinking, smoking and unhealthy diet increase the risk of breast cancer.

- **Chemical Exposure**
  - Exposure to certain chemicals can increase breast cancer risk.

- **Breastfeeding**
  - Mother’s who breastfeed can lower their breast cancer risk.
Problem Definition & Operational Environment
Beast Cancer in Saudi Arabia

- Breast Cancer, especially among women, is a significant public health risk in the Kingdom of Saudi Arabia.
- It is ranked first among female diagnosed cancer cases,
- Breast cancer accounts for 29.1% of female cancer cases.
- Considered the most common cancer among women, with the highest risk of spreading to other parts of the body.
- The average age that women in the Kingdom of Saudi Arabia are diagnosed is at age 48, with most cases ranging from ages 43 to 52.
# Saudi Cancer Statistics

<table>
<thead>
<tr>
<th>Sites</th>
<th>Male</th>
<th>Female</th>
<th>All</th>
<th>%</th>
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</thead>
<tbody>
<tr>
<td>Breast</td>
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<tr>
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<td>Thyroid</td>
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<td>311</td>
<td>746</td>
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<tr>
<td>Leukemia</td>
<td>402</td>
<td>282</td>
<td>684</td>
<td>5.9</td>
</tr>
<tr>
<td>Liver</td>
<td>339</td>
<td>156</td>
<td>495</td>
<td>4.3</td>
</tr>
<tr>
<td>Lung</td>
<td>326</td>
<td>109</td>
<td>435</td>
<td>3.7</td>
</tr>
<tr>
<td>Hodgkin disease</td>
<td>239</td>
<td>154</td>
<td>393</td>
<td>3.4</td>
</tr>
<tr>
<td>Stomach</td>
<td>195</td>
<td>121</td>
<td>316</td>
<td>2.7</td>
</tr>
<tr>
<td>Kidney</td>
<td>193</td>
<td>120</td>
<td>313</td>
<td>2.7</td>
</tr>
</tbody>
</table>
# Saudi Cancer Statistics

## Table 2.5 Most Common Cancers among Saudis by sex, 2013

<table>
<thead>
<tr>
<th>Male</th>
<th>5281</th>
<th>%</th>
<th>Female</th>
<th>6364</th>
<th>%</th>
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</thead>
<tbody>
<tr>
<td>Colorectal</td>
<td>736</td>
<td>13.9</td>
<td>Breast</td>
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<td>4.9</td>
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<tr>
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<td>Corpus Uteri</td>
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<tr>
<td>Prostate</td>
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<td>Leukemia</td>
<td>282</td>
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<tr>
<td>Hodgkin disease</td>
<td>239</td>
<td>4.5</td>
<td>Ovary</td>
<td>194</td>
<td>3.0</td>
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<td>Bladder</td>
<td>227</td>
<td>4.3</td>
<td>Liver</td>
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<td>2.4</td>
</tr>
<tr>
<td>Kidney</td>
<td>193</td>
<td>3.7</td>
<td>Brain</td>
<td>128</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Problem Statement

Breast cancer is a public health issue in KSA, as it is the leading type of cancer. For the most part, it affects women far greater than men. In KSA, culture as well as a lack of public awareness, is a barrier to early detection through breast cancer screening, resulting in higher rates of mortality.
Exploratory Research

Three main issues leading to poor breast cancer outcomes:

1. Low Level of Public Awareness
2. Lack of Public Education
3. Culture & Fear

Poor Breast Cancer Public Health Outcomes
The level of your knowledge about Breast Cancer

Excellent
Good
Average
Very Weak
I don't know any thing

Have you ever done any kind of Breast Cancer tests?

Yes
No

What do you think is the biggest barrier for Saudi women of detecting breast cancer early?

Unawareness
Fear
Shyness
Others
Exploratory Research: Public Breast Cancer Awareness

Public Awareness
- No central public health program with breast cancer awareness mission exists
- Efforts are sparse and minimal
- Lacking ability to engage stakeholders and national audience

Public Education
- Lack of existing Public education programs.
- No proactive educational programs large enough to make a significant impact.

Culture & Fear

Culture
- Likely to go to doctor when something is wrong, not likely to take preventative action
- Screening tests invade personal space
- Women prefer to be tested by women technicians and physicians for testing
- Preference for privacy

Fear
- Unwillingness to test when nothing is wrong
- Fear of negative results or bad news
Identifying Key Stakeholders & Documenting Stakeholder Needs
Key Stakeholders

- **Female Saudi Citizens** – Highly impacted by breast cancer.

- **Male Saudi Citizens** – At lower rates. Additionally, female family members and friends at risk for breast cancer will impact males.

- **Foreign Workers** – Makeup a sizable population in Saudi Arabia and utilize the KSA health system, so a system solution will have an impact on them.

- **Saudi Government** – If any public funding or mandates with a system solution are required, the Saudi Government will need to approve.

- **Ministry of Health** – Government ministry in charge of managing public and private healthcare at all levels, the promotion of public health, the prevention of diseases and development of health related laws.

- **Private Hospitals** – Hospitals that are privately operated.

- **Non-profit Organizations** – Private organizations with missions to fight breast cancer, promote awareness and increase public education.

- **Private Insurance** – Additional insurance options to help cover costs of private healthcare.
Documenting Stakeholder Needs

Female Saudi Citizens/Male Saudi Citizens and Foreign Workers:

1. The system shall support mammogram and ultrasound breast cancer screening.
2. The system shall maintain confidentiality of medical information.
3. The system shall ensure the privacy of patients.
4. The system shall educate the public on breast cancer.
5. The system shall provide reasonable advance notice via mail and text message for any mandated testing.
6. The system shall enforce screening requirements.
7. The system shall facilitate and encourage breast cancer screening.
8. The system shall include adequate female technician staff.
9. The system shall accommodate patients with requests for female technician staff.
10. The system shall ensure that all females obtain breast cancer screening before age 48.
• Saudi Government/Ministry of Health/Ministry of Education

13. The system implementation and design costs shall not exceed the allocated funding from the government.

14. The system operational costs shall not exceed allocated funding from the government.

15. The system shall be integrated with existing government systems, programs and processes.
• **Private Hospitals/Private Insurance**

16. The system shall be well integrated with private hospitals.

17. The system shall provide private insureds with medical referral to private hospitals.

• **Non-profit Organizations and other Institutions**

17. The system shall coordinate the efforts of other participating institutions, such as non-profits, schools mission-based organizations to improve breast cancer outcomes.
Project Objective

Develop a system solution to improve public health outcomes for breast cancer in the Kingdom of Saudi Arabia.
Analysis of Alternative Systems
Alternative #1: Mandatory Screening
(Prior to Age 48 – National ID Renewal)

System Requirements:

1. The system shall require all females to get a breast cancer screening by a licensed physician prior to Age 48.

2. The system shall withhold issuing National ID at age 48 for those who do not complete the breast cancer screening requirement.

3. The system shall require proof of breast cancer screen (i.e. a form signed by physician) in order to issue Age 48 National ID.

4. The system shall issue notices of breast screening requirement at least one year before person’s 48th birthday.

5. The system shall be integrated with the Ministry of Interior database.

6. The system shall be programmed to identify people turning 48 and automatically issue notice by letter via mail and through text message.
Alternative #1: Mandatory Screening Operational Node Connectivity

KSA GOVERNMENT

MINISTRY OF HEALTH

MINISTRY OF INTERIOR

PUBLIC HEALTHCARE SYSTEM

PRIVATE HEALTHCARE SYSTEM

KSA FEMALE CITIZEN
Alternative #1: Mandatory Screening
Dataflow Diagram

KSA GOVERNMENT

MINISTRY OF INTERIOR

CREATE SCREENING RESTRICTION

QUERY DATABASE

CREATE RECORD

MINISTRY OF HEALTH

GENERATE NOTIFICATION

MINISTRY OF INTERIOR DATABASE

MINISTRY OF HEALTH DATASTORE

KSA FEMALE CITIZEN
Alternative #2: Scholastic & Employer Requirements

System Requirements

1. The system shall incorporate breast cancer education into the public school program/curriculum.

2. The system shall delegate development breast cancer education program for public schools to the Ministry of Education.

3. The system shall provide Principals and School Administrators with 8 hours of training covering the delivery of breast cancer education.

4. The system shall coordinate teacher training on the delivery of breast cancer education.

5. The system shall delegate development of employer breast cancer education training to the Ministry of Labor.

6. The system shall mandate all employers with 10 or more employees, provide at least one hour per year, breast cancer education training to employees using program developed by Department of Labor.

7. The system shall mandate all government employers provide at least one hour per year, breast cancer education training to employees using program developed by Department of Labor.
Alternative #2: Scholastic/Employer Requirements

Operational Node Connectivity

- Ministry of Health
- Ministry of Education
- Ministry of Labor
- Government Employer
- Primary, Middle or High School
- College or University
- Private Employer (10+ Employees)
Alternative #3: Media Campaign

System Requirements:

1. The system shall implement national media campaign to promote breast cancer education and awareness.

2. The system shall establish funding to cover expenses that include:
   a. An official website for breast cancer education, events, seminars and workshops.
   b. Production of breast cancer awareness videos featuring celebrities and public figures.
   c. Social media presence promoting the campaign on the major social media platforms.
   d. Annual events during Aljenadriah spanning 15 days through February.

3. The system shall have the capability to share information via social media platforms.
Alternative #3: Media Campaign
Mockup – Website Concept

Main Menu

Sub-Menu
Information Resources

Sub-Menu
Documents

Sub-Menu
Public Forums

Social Media

Schedule
Upcoming Events

Slideshow
Announcements & Developments

Instagram Slideshow

External Links
Government Ministries
Public Health Organizations
Hospitals and Healthcare Providers

Facebook Posts

Blog

Sub-Menu
Information Resources
Breast Cancer Information
Healthcare Providers
Screening Mandate
Seminars and Workshops
Insurance
Events

Sub-Menu
Documents
National ID Form
Screening Certification

Sub Menu
Public Forums
Message Boards
Public Events
Frequently Asked Questions
Submit Recommendations
Measures of Effectiveness (MoEs)
Measures of Effectiveness (MOEs)

- Cost
- Implementation Time
- Size of Audience Reached
- Proportion of Targeted Group Reached
- Ease of Implementation
- Enforcement of Requirements
# Measures of Effectiveness (MOEs)

<table>
<thead>
<tr>
<th>Measure of Effectiveness</th>
<th>System 1: Mandatory Screening</th>
<th>System 2: Scholastic/Employer Requirement</th>
<th>System 3: Media Campaign</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong></td>
<td>Low (3)</td>
<td>High (1)</td>
<td>Medium (2)</td>
</tr>
<tr>
<td><strong>Implementation Time</strong></td>
<td>Low (3)</td>
<td>Medium (2)</td>
<td>High (1)</td>
</tr>
<tr>
<td><strong>People Reached</strong></td>
<td>Medium (2)</td>
<td>Low (3)</td>
<td>High (1)</td>
</tr>
<tr>
<td><strong>Target Group Reached</strong></td>
<td>High (1)</td>
<td>Medium (2)</td>
<td>Low (3)</td>
</tr>
<tr>
<td><strong>Ease of Implementation</strong></td>
<td>Low (3)</td>
<td>Medium (2)</td>
<td>High (1)</td>
</tr>
<tr>
<td><strong>Enforcement</strong></td>
<td>High (1)</td>
<td>Medium (2)</td>
<td>Low (3)</td>
</tr>
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</table>
Optimal System Solution

- Each of the system alternatives have clear advantages and disadvantages.
- The advantages and disadvantages appear to be unique to each system and do not overlap.
- A system solution that incorporates elements of each alternative system will be optimal in providing the functions and capabilities to satisfy user/stakeholder requirements.

Optimal System Solution:

Top-level system incorporate each alternative as sub-systems or components.
System Architecture
Optimal System Solution
Top Level System Hierarchy

- Sub-System 1: Mandatory Screening Program
- Sub-System 2: Scholastic and Employer Education Requirement
- Sub-System 3: Public Awareness & Media Campaign
Operational Concept Graphic

Top-Level System

- Breast Cancer Screening Mandate
- Media Campaign
- Scholastic & Employer Education Requirement

Collaboration with Public & Private Healthcare
National ID Processing
Screening Notifications
Website
Public Events
Social Media
Public School Education
Employee Training

Private Employers (10+ Employees)

Social Influence

Private Healthcare
Public Healthcare

Age 48 Female Saudis
Female Saudis
Students
Male Saudis
**Alternative #1: Mandatory Screening**
(Prior to Age 48 – National ID Renewal)

<table>
<thead>
<tr>
<th>System Requirement</th>
<th>Verification Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>The system shall require all females to get a breast cancer screening by a licensed physician prior to Age 48.</td>
<td><strong>Testing</strong> - audit with a random sample generated of 1000 records that meet criteria, to ensure 100% accuracy.</td>
</tr>
<tr>
<td>The system shall withhold issuing National ID at age 48 for those who do not complete the breast cancer screening requirement.</td>
<td><strong>Testing</strong> – using sample of 100 records who have and 100 who have not completed requirement to verify if MOI database has 100% accuracy in correct eligibility status.</td>
</tr>
<tr>
<td>The system shall require proof of breast cancer screen (i.e. a form signed by physician) in order to issue Age 48 National ID.</td>
<td><strong>Analysis</strong> – using computer analytic technique, verify that system correctly updates record when proof of screening is submitted.</td>
</tr>
<tr>
<td>The system shall issue notices of breast screening requirement at least one year before person’s 48th birthday.</td>
<td><strong>Demonstration</strong> – will display performance of operations in issuing notices for records that meet criteria of 1 year before 48th birthday.</td>
</tr>
<tr>
<td>The system shall be integrated with the Ministry of Interior database.</td>
<td><strong>Analysis</strong> – using computer analytic technique to interpret proper integration.</td>
</tr>
<tr>
<td>The system shall be programmed to identify people turning 48 and automatically issue notice by letter via mail and through text message.</td>
<td><strong>Demonstration</strong> – demonstrate accurate programming and operations in issuing mail and text message notices for records that meet criteria.</td>
</tr>
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</table>
## Alternative #2: Scholastic & Employer Requirements

<table>
<thead>
<tr>
<th>System Requirement</th>
<th>Verification Method</th>
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<tbody>
<tr>
<td>The system shall incorporate breast cancer education into the public school program/curriculum.</td>
<td><strong>Demonstration</strong> — demonstrate breast cancer education in public schools.</td>
</tr>
<tr>
<td>The system shall delegate development breast cancer education program for public schools to the Ministry of Education.</td>
<td><strong>Demonstration</strong> — demonstrate breast cancer education developed within schools.</td>
</tr>
<tr>
<td>The system shall provide Principals and School Administrators with 8 hours of training covering the delivery of breast cancer education.</td>
<td><strong>Certification</strong> — Each school will certify principals and school administrators have received 8 hours of training.</td>
</tr>
<tr>
<td>The system shall coordinate teacher training on the delivery of breast cancer education.</td>
<td><strong>Certification</strong> — Each school will certify teachers were trained on delivery of breast cancer education.</td>
</tr>
<tr>
<td>The system shall delegate development of employer breast cancer education training to the Ministry of Labor.</td>
<td><strong>Demonstration</strong> — MOL will demonstrate developed breast cancer education training for employers.</td>
</tr>
<tr>
<td>The system shall mandate all employers with 10 or more employees, provide at least one hour per year, breast cancer education training to employees using program developed by Department of Labor.</td>
<td><strong>Certification</strong> — Each private employer will annually certify their number of employees and that they delivered 1 hour breast cancer education/training per year.</td>
</tr>
<tr>
<td>The system shall mandate all government employers provide at least one hour per year, breast cancer education training to employees using program developed by Department of Labor.</td>
<td><strong>Certification</strong> — Each public employer will annually certify delivery of 1 hour breast cancer education/training per year.</td>
</tr>
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# Alternative #3: Media Campaign

<table>
<thead>
<tr>
<th>System Requirement</th>
<th>Verification Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>The system shall implement a coordinate national media campaign to promote breast cancer education and awareness.</td>
<td><strong>Demonstration</strong> – national media campaign will be demonstrated to the public.</td>
</tr>
<tr>
<td>The system shall establish funding of to cover expenses that include:</td>
<td><strong>Inspection</strong> – inspect annual budget to ensure adequate funds to cover website development, production of videos, social media campaign and the cost of annual events.</td>
</tr>
<tr>
<td>a. An official website for breast cancer education, events, seminars and workshops.</td>
<td></td>
</tr>
<tr>
<td>b. Production of breast cancer awareness videos featuring celebrities and public figures.</td>
<td></td>
</tr>
<tr>
<td>c. Social media presence promoting the campaign on the major social media platforms.</td>
<td></td>
</tr>
<tr>
<td>d. Annual events during Aljendariah spanning 15 days through February.</td>
<td></td>
</tr>
<tr>
<td>The system shall have the capability to share information via social media platforms.</td>
<td><strong>Testing</strong> – test the capability of website to properly share content through social media platforms.</td>
</tr>
</tbody>
</table>
# Verification and Validation

<table>
<thead>
<tr>
<th>Stakeholder Requirements</th>
<th>System Requirements</th>
<th>Verification</th>
<th>Validation</th>
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</thead>
<tbody>
<tr>
<td>Confidential Medical Information</td>
<td>Sub-System 1: Mandatory Screening</td>
<td>USER REQUIREMENT SATISFIED</td>
<td>System Validated - System Meets User Requirements</td>
</tr>
<tr>
<td>Privacy</td>
<td>Sub-System 2: Scholastic/Employer Requirement</td>
<td>USER REQUIREMENT SATISFIED</td>
<td></td>
</tr>
<tr>
<td>Reasonable Advance Notice</td>
<td>Sub-System 3: Media Campaign</td>
<td>USER REQUIREMENT SATISFIED</td>
<td></td>
</tr>
<tr>
<td>Enforcement</td>
<td></td>
<td>USER REQUIREMENT SATISFIED</td>
<td></td>
</tr>
<tr>
<td>Employer Participation</td>
<td></td>
<td>USER REQUIREMENT SATISFIED</td>
<td></td>
</tr>
<tr>
<td>Mandatory Screening</td>
<td></td>
<td>USER REQUIREMENT SATISFIED</td>
<td></td>
</tr>
<tr>
<td>Promote Awareness</td>
<td></td>
<td>USER REQUIREMENT SATISFIED</td>
<td></td>
</tr>
<tr>
<td>Automated Text Message &amp; Mail Notification</td>
<td></td>
<td>USER REQUIREMENT SATISFIED</td>
<td></td>
</tr>
</tbody>
</table>
Risk Management

The key risks identified:

1. Cost
2. Government Implementation
3. Public Participation
4. Healthcare System Capacity
**Risk Management: Cost**

- **Risk**
  Costs of system implementation and operation exceed budget.

- **Implications**
  Funds are not sufficient to properly implement and operate the system.

- **Mitigation Strategy**
  - Accurately project costs with flexibility for potential changes
  - Monitor and review costs to make sure they adhere to the baseline projections
Risk Management: Government Implementation

- **Risk**
  Program not implemented due to rejection by Government.

- **Implications**
  System failure, the system depends on government participation for implementation and operation.

- **Mitigation Strategy**
  - Ensure that government ministries understand the social benefits
  - Establish a long-term funding allocation of resources that satisfies both government and system requirements
Risk Management: Public Participation

• Risk

Level of participation is not enough, or face pushback from public.

• Implications

Non-participation of any key stakeholder group severely impacts system performance.

• Mitigation Strategy
  - Government mandate ensures participation.
  - Media campaign creates social influence to encourage participation.
Risk Management: Healthcare System Capacity

• **Risk**
  
  Size of healthcare system may be insufficient to efficiently provide care to influx of new patients.

• **Implications**
  
  System delays and bottlenecks, inefficiency, low user satisfaction.

• **Mitigation Strategy**
  
  - Constant monitoring and projecting of patient participants in public and private healthcare system.
  
  - Ongoing operational monitoring of staff levels to ensure adequate staffing.
Operational Stage: Lean Thinking

1. Value
   Improve public awareness.
   Better health outcomes.

2. Value Stream Map
   Automation of identifying users and delivery of notifications.

3. Create flow
   Streamlined processes in notifications, users efficiently complete screening requirement.

4. Let Users Pull Value

5. Continuous seek perfection
Ethical Issues

Ethical Lenses

- Rights
- Virtue
- Utility
- Justice

Two main ethical considerations:

1. **Rights**: The right to make personal decisions about what health related actions to take

2. **Utility**: The ethical value of social utility – measuring the total benefits of the program to reduce suffering, pain and death.
Conclusion

- Identified Issue of Breast Cancer as a Public Health Issue in KSA
- Goal – Develop a System Solution to the Issue
- Formulated three System Alternatives
- Performance Analysis – Measures of Effectiveness
- System Solution – Combined Alternatives for Comprehensive Solution without Redundancy
- Risk Management Strategy to Mitigate Risks
- Ethical Considerations
Lessons Learned

- Alternative system concepts can be refined and incorporated into a larger system solution that address various aspects of the problem.

- Public participation and stakeholder engagement is critical to a national system solution.

- It is essential to analyze ethical considerations through various lenses when determining the individual and social value of the system to key stakeholders.
References


- http://www.breastcancer.org/symptoms/understand_bc/what_is_bc

- http://triplestepwardthecure.org/understanding.php