"IMPACT OF SIMULATOR BASED TEACHING PROGRAM OF BMW SEGREGATION ON HOSPITAL INFECTION CONTROL IN A HOSPITAL IN SOUTHERN INDIA"

ABSTRACT:

Introduction: Biomedical waste (BMW) generated is a matter of great concern as it consists of high levels of hazardous waste. The lack of segregation and disposal policy in India leads to use of such infectious waste in day-to-day life. Lack of awareness about segregation of BMW at source is a major cause for hospital acquired infection and increased risk of contamination of hospital and external environment.

Materials & Method: To address the problem, we decided to train interns and health care workers to increase their awareness about BMW segregation and thereby reduce HAI.

The program was run in 3 phases. In the 1st phase need assessment was done as to how important and effective this program would be in controlling HAI. The 2nd phase comprised of identifying the stake holders in the program who will play the key role in implementing the program effectively. The 3rd phase evaluation of BMWSP focused on the outcomes as enumerated in the Kirkpatrick model (Kirkpatrick, 2006)[6], viz., participants' reaction, learning, change in behavior and results. Measuring the impact of the program on the learners at these four levels revealed the effectiveness of the program.

Results: To overcome the shortfalls in the Kirkpatrick model we used Logic model which took care of the instructional design. **Logic model** is better suitable for evaluating BMWSP as it considers inter-relation between constituents in a sequence and their effect on the process as well as product providing the necessary roadmap from the planned work (inputs and activities) to the intended results (outputs, outcomes and impact). It is a sequence of events connecting each other starting with Resources/ Inputs, Activities, Outputs, Outcomes and Impact. The model helped medical interns and dental students to understand the importance for BMWSP and also made a significant difference in its implementation.

Conclusion: The program will help in making the health care staff more aware about BMWSP. It will also increase their knowledge, and will help in the implementation of the program. This will significantly reduce HAI and overall benefit the society.

KEY WORDS: BMW, HOSPITAL INFECTION CONTROL, WASTE,TEACHING.

Introduction / Background:

Biomedical waste (BMW) generated is a matter of great concern as it consists of high levels of hazardous waste. The lack of segregation and disposal policy in India leads to use of

such infectious waste in day-to-day life (Nagaraju, Gv, Ds, Mp, & Sp, 2013) [1]. Lack of awareness about segregation of BMW at source is a major cause for hospital acquired infection and increased risk of contamination of hospital and external environment.

To address the above problem in SDCH, our dean suggested that interns and health care workers (HCW) dealing with BMW be trained in BMW segregation. A 'Bio Medical Waste Segregation Program' (BMWSP) was proposed to increase their awareness on the issue thereby reducing the incidence of hospital acquired infections in the long run.

It was essential to evaluate the BMWSP program to check whether it would meet its objectives and achieve its desired outcomes. Program evaluation (PE) is the process of judging the worth of a program and this judgment is shaped by comparing as to what the program is, withcriteria about what the program should be.(Steele,n.d.)[2] To evaluate BMWSP, we intend to follow the protocol of Seven phases of Program Evaluation as per the MHPE unit book.

Phase 1: Need assessment:

It is a very important to evaluate BMWSP whether and how it impacts the practices of students in infection control, and also from the point of view of hospital infection control. Therefore, program should go well and be successful. Proper evaluation will help in the successof the program. Data regarding incidence of HAI in SDCH, Pune the past few years was collected in simple questionnaire from Infection Control Committee of the College. There is a strong evidence of transmission HIV/AIDS, Hepatitis B and C, through biomedical waste.

(Organization, 1999). Qualitative and Quantitative Data on Likert's scale to be collected from the health care workers and management of BMW disposal agency. Simple data collection methods like questionnaires to collect Feedback from patients, Screening tests and separate Questionnaires for students, faculty, management and HCW and attendants to test their awareness on the matter. Interviews of Dean, senior faculty, management, were conducted in standardized format. Focused Group Discussions was done with Dean, senior faculty, management to assess the need for the program.

Need assessment contain three aspects of Program Evaluation7, Structure, Process and Outcome. As regards structure, we evaluated whether funds allocated and manpower is adequate for BMWSP, whether materials / equipment required are in sufficient quantity. The above data was obtained from administration.

Through **evaluation of process,** we came to know how the program is running. **Formative evaluation** was done during the program, so that we can fine tune the program and make necessary changes when the program is running. With **Summative evaluation**, at the end of the program we planned to evaluate its impact and effectiveness, whether it could bring in the desired behavior change towards BMWM. Though students are the main stakeholders, feedback and perception of others stakeholders is also necessary to get a 360-degree appraisal to know the effectiveness of the program.

Outcome evaluation is concerned with the results in two spheres; student related and overall improvement in Hospital infection control protocols.

Phase 2: Identifying key stakeholders:

- Using the sequence of events in the Logic model, the stakeholders are identified as follows;
- Program participants - Students, Interns, Health care workers dealing with BMW,
- Faculty for the program – Microbiology Department.
- Medical Education Unit of SDCH, Pune
- Project team – Dean, Head of the departments, Representatives of HCW and Interns
- Infection Control Committee
- Funders – President, senior management

- BMW collecting and disposal agency
- General public – Patients, patient relatives, attendants

Phase 3: Determine program logic model:

Three important theories that form the foundation for program evaluation models are, complexity theory, reductionism and systems theory (Frye & Hemmer, 2012)[3]**.** (Table – Theories of Evaluation -Annexure- I). Different models are used for different settings for evaluation.

Quasi-experimental model is based on reductionism theory and useful in drug trials/ Laboratory experiments, etc. CIPP model (Context /Input / process / products) is based on the theory of complexity. This theory considers diversity of system in which, ambiguity and uncertainty are natural phenomenon.

Program evaluation (PE) is a complex process which can be undertaken using different approaches. It is important to be flexible and adopt a suitable method for PE in specific situations (*Evaluation Models 2*, 2001)[4]. On review of literature, we found that **Kirkpatrick's** four level evaluation and Logic models based on System theory are suitable for the evaluation of BMWSP[6]. Kirkpatrick's four level evaluation model is extensively employed to evaluate the effectiveness of educational programs (Gill & Sharma, 2013)[5]. System theory considers that the whole is greater than sum of its parts. A system consists of the constituent parts, their interrelationship with one another and interaction with the environment. An open system believes that change is bound to happen with time. This theory helps in understanding the achievement of intended goals and unintended goals.

The evaluation of BMWSP will be focusing on the outcomes as enumerated in the Kirkpatrick model (Kirkpatrick, 2006)[6], viz., participants' reaction, learning, change in behavior and results. Measuring the impact of the program on the learners at these four levels will revealthe effectiveness of the program.

Reaction: We intended to get written feedback of the participants on Likert scale for quantitative evaluation and open ended questions for qualitative. Whether the students liked the program? How many attended? How many students interacted positively in the program? (Feedback form for BMWSP-Annexure-II)

Learning: We intended to check the learning of the participants before and after the program by use of Pre-Test and Post-test questionnaire methods. We also measured the resulting increase

in students' knowledge or capability (achievement of learning) as defined by the specific learning objectives of the program.

Behavior: Change in behavior is the outcome expected and can be observed. The learners should be able to segregate BMW in real life situation all the times. Rewards, forming clubs or groups for best practices etc., could help in achieving desirable change in behavior.

Results: Results will depict what is the return on our investment (time, money, infrastructure and human expertise) in the form of organizational goals.

We could gather data for evaluation in the form of questionnaire feedback surveys (quantitative and qualitative) from various sources, viz., patients, self, peers, patient attendants, litigations and complaints filed against residents, standardized patients (if possible) and medical and paramedical staff besides assessment of PG residents by OSPE.

However, the main focus of Kirkpatrick model (Kirkpatrick, 2006)[6], is on the outcomes especially the immediate ones. A drawback of Kirkpatrick model is that it is commonly employed model at reaction level, however what should be the chief indicator at this level and other levels is not described well (Topno, 2012)[7]. Kirkpatrick's model is not appropriate from the point of view of variables that affect the outcomes of a program, because by this model lower levels are very easy to assess, while at the higher level assessment is progressively difficult.

There could be difficulty in gathering data for assessing the desired behavior change in the workplace as behavior change is a long term outcome that we may not be possible to observe for a small educational program like BMWSP. When the students leave college, there is no resource to evaluate their behavior.

The advantage of this model is that it is very easy to understand and helpful for an evaluator to understand the various outcomes which are needed to be studied and may be useful along with other models, especially to define learner outcome.(Frye & Hemmer, 2012)[3]. **To deal with deficiencies of Kirkpatrick model**, we will take care of the instructional design. The supportive and procedural information is to be provided during BMWSP. We have to evaluate the effect of implementation of learning tasks, part-time practice, reflection, feedback and testing components of the model post BMWSP at departmental level. {Instructional design model (4C/ID)}(Vandewaetere.et.al.,2015).[8]

We will use Logic model because it simplifies the complexity of a program, this model is useful for planning and evaluation of program, it's easy to understand and evaluator friendly. Organizations who are funding for the programs need the submission of program proposal with logic model (Frye & Hemmer, 2012)[3].

The logic model represents a series of logically related assumptions about the program's participant population and the changes we hope to bring about in that population as a result of our program. It reflects how the program will work and how it will have its effect on the target population (Darnes Bell, Joan W, Susan Fint, n.d.).[9]

Logic model is better suitable for evaluating BMWSP as it considers inter-relation between constituents in a sequence and their effect on the process as well as product providing the necessary roadmap from the planned work (inputs and activities) to the intended results (outputs, outcomes and impact). It is a sequence of events connecting each other starting with Resources/ Inputs, Activities, Outputs, Outcomes and Impact (W.K. Kellogg Foundation, 2004).[10]

The inputs include the time, money, infrastructure and human expertise that go into developing a program. The activities refer to all the strategies, innovations and changes being planned as part of the program. The outputs consist of the 'products' of the program, like number of subjects trained, number of modules created and so on. The outcomes of the program can be divided into short-term, intermediate and long-term outcomes.

This model provides a road map describing the sequence of related events connecting the need for the planned BMWSP with the program's desired results. Mapping a proposed BMWSP helps us visualize and understand how man, material and money can contribute to achieving our intended program goals and can lead to program improvements. Funding agencies require the submission of a logic model as part of the program proposal (Frye & Hemmer, 2012)[3].

A clear link between different program components is established. This model can be used for planning a program as well as for evaluating a program. It is simple to understand and use.

A template on the basis of Logic model is prepared for the BMWSP in the table 1 below.

DESCRIPTION OF SOLUTION: What is the purpose/goal of the Health activity? *Use of simulators for improving BMW segregation practices among interns in Sinhgad Dental College Hospital, Pune*			
ACTIVITIES ***What are the main things the project will do/provide?*** ***(Examples: events, trainings, workshops, promotions, send messages, collect data, etc.)*** ***1) Training workshops for interns/HCW*** ***2) Workshop certificates*** ***3) Feedback – written and video*** ***4) Collecting data – assessment data,*** ***5) Simulation preparation***	***OUTPUTS*** ***What are the direct tangible products of the activities?*** ***(Examples: # of trainings, # of sessions, # of messages sent, frequency of data collected, etc.)*** ***1) Number of workshops – 2 per year*** ***2) Frequency of data collection – 2 per year*** ***3) Number of interns trained – 100 per year***	***OUTCOMES*** ***What are the results of your program? (Examples: % change in behavior, attitudes, awareness, skills, etc.)*** ***1) Increase KSA among interns*** ***2) Better BMW segregation practices*** ***3) Better cleanliness and hygiene in the hospital*** ***4) Reduced risk for health care workers***	***IMPACT*** ***What are the long-term results of your program?*** ***(Example: improved health outcomes)*** ***1) Reduced incidence of HAI*** ***2) Improved image of the hospital*** ***3) Less litigations related BMW Act violations***

The Inputs (time, money, Resources, infrastructure and expertise etc.), **Activities** (Stimulatory educational program Interventions), **Outputs** (Product), **Outcomes** (Immediate, Short term (2 to 3years) and **Impact** (Long term -5to 10 years) are spelt out clearly which will facilitate effective program planning, implementation, and evaluation.

The evaluation BMWSP focuses on the program's implementation and participant outcome objectives. The program model includes the 'Assumption' and 'Response' features. We make the following assumption about our target population:

Assumption: Lack of awareness about segregation of BMW at source is a major cause for hospital acquired infection and increased risk of contamination of hospital and external environment.

Response: To develop an educational intervention program 'Bio Medical Waste Segregation Educational Program' (BMWSP) that provides necessary knowledge and training for interns and health care workers (HCW) dealing with BMW.

Other models not suitable for BMWSP evaluation: Quasi-experimental model is useful in drug trials/ Laboratory experiments would not be appropriate to evaluate BMWSP. **CIPP model** (Context /Input / Process / Products) would not be necessary for evaluation of simple educational program as it involves quite complex procedures of data collection and will not be very feasible in BMWSP.

Phase 4: Identify resources available for the program evaluation:

Resource scarcity is the most important constraint for evaluation. So it should be taken into consideration before evaluating any program. We should focus beforehand on whether program is feasible. Feasibility of program evaluation has to take into account the following factors: a) Practical procedures; b) Political viability; c) Cost effectiveness (Sanders, 2010)[11]. In evaluation of BMWSP, the input, process and output are feasible. However, it may require morefaculty members in the team, with dedicated time. The tools needed to collect the data need to be validated. Evaluation of the outcome and impact of the BMWSP are feasible. We may apply forgrants from internal as well as external funding agencies to finance the program.

BMWSP PROGRAM THEORY

Outcomes

Figure 1 : Expected outcomes of the BMWSP are given in Annexure-III.

Phase 5: Collect and critically examine data:

Before collecting data we have to determine what type of data is relevant to BMWSP. This can be determined by identifying evaluation questions of BMWSP. The main purpose of the evaluation is to assess the outcomes and impact of the BMWSP. Quantitative data and qualitative data collected will be analyzed.

Data collected from Infection Control Committee of the College revealed there is a rise in incidence of HAI in last 3 years. Data collected from the responses to interviews of BMW clearing and disposal agency also revealed that BMW was not being segregated at source to the desired extent. Feedback from patients revealed that they are not happy with the present BMWS practice. Responses to questionnaires and screening tests from students, faculty, management and HCW and attendants revealed their lack of awareness on the matter. Interviews and Focused Group Discussions with Dean, senior faculty, management indicated that there was a need for the program.

It was found that traditional didactic lectures would be monotonous and would not be effective for the interventional program. Computer aided Simulator training program, hands on experience and interactive lectures are more needed. Focused Group Discussions to be held with Project Team to prepare a curriculum for the program.

The feedback questionnaires and interviews revealed that the educational intervention is best suited for Interns and HCW as the former are in clinical practice and latter guide the handler of the BMW. Pre-test and post-test questionnaires for participants in English and vernacular medium for assessing the impact of the program reveal there is improved awareness on the matter.

Our Program interventions are to increase their awareness about BMWS, provide knowledge on the importance of BMW and BMWS and to provide education and training on BMWS. The Immediate, intermediate and long term outcomes are detailed in **Annexure IV.**

The Evaluation questions are mainly based on the objectives of BMWSP and are as follows:

Input Related Questions:

- Infrastructure & facilities at the college are adequate for conducting the program?
- Profile of the course faculty running the program?
- Whether educational resources provided to the participants have the quality?
- How much institutional support for the faculties to conduct the program?
- How much support for the interns to attend the program from different departments?

Activity Related Questions:

- Pre-program communication with the interns is adequate?
- Quality of BMWSP session conducted?
- Validity of the assessment of the interns?
- Feedback of the interns implemented constructively for improvement in the program?

Output related Questions:

- What is the reaction of the Interns to the program?
- What is the reaction of the faculty to the program?
- Has the knowledge, skills and behavior of Interns improved after the program?

Impact related Questions:

- Has the quality of BMWS improved in the department from where Intern have attended the program?
- Has the program improved the ability of Interns to implement BMWS?
- Are the Interns who have attended BMWSP workshop are competent in BMW segregation
- Have incidences of hospital acquired infection reduced in the SDCH, Pune.

The input and output evaluation questions are concerned with the organizers. We can statistically quantify it by simple data collection methods. The activity related questions are for the assessment of the quality of the activities. The outcome related questions data can be collected using feedback questionnaires and pre and post-tests. Impact related questions will be of interest to each and every stakeholder. This data will include intern's assessment results, focus group discussions and in-depth interviews of interns and faculty. Data relating to Hospital acquired infection in the last three years needs to be collected.

The need of different stakeholders for PE is specific. Therefore, a variety of evaluation methods are required. The data and methods used to collect it are dependent on the stakeholders need, these include qualitative and quantitative methods. The quantitative data will be described as mean and standard deviations for numerical data. Pre-and post-test scores of BMWSP will be compared by a paired T-test.

Phase 6: Formulate findings, synthesize from data sources and formulate major findings:

After analysis of evaluation data, it is of utmost importance that the results are scrutinized for their accuracy, propriety and utility when they are being formulated. The utility of a programrefers to how useful the results of the evaluation are to the specific stakeholders. Propriety is concerned with the legal and ethical aspects of the program evaluation. The accuracy of a program evaluation refers to the veracity of the information that is collected (Sanders, 2010).[11]

Phase7: Communicating findings

Our strategy for effective communication of the program evaluation findings would be use of newsletters, brochures, electronic responses, presentations for the Program participants.

Workshops, internal reports, performance indicators and presentations could be used for the project team**.** There are some key points to be considered while communicating program evaluation results. Program evaluation reporting must be actionable and enable the results to be used for improvement. The evaluation report should adhere to the standards of utility, feasibility, propriety, and accuracy. The data should be presented in a manner that can be understood easily, the recommendations should emphasize the take-home massage and a concrete plan for the future (**Elmi, n.d.)[12]**. The evaluation report must be both informative as well as concise. This can be achieved by having a format of reporting that contains a summary, background, methods, findings and recommendations. A communication strategy should be devised for each of the stakeholders as their requirements from the evaluation are likely to be quite different. Specific formats are useful for communicating to specific stakeholders. For the Management and the funding bodies it could be Recommendations, briefings, presentations, Seminars, summary reports, and data summary sheets that bring out the cost efficiency of the program.

Producing press releases and articles for local professional publications, such as newsletters and journals, making presentations at meetings on the results of our program **at the local health department, university,** listing our evaluation report or other evaluation-related publications in relevant databases and scheduling meetings with similar programs to share our experience and results will be considered. **(Darnes Bell, Joan W, Susan Fint, n.d.).[9]**

The interns will be the direct beneficiaries of the newly implemented BMWSP. They could be given a brief presentation. The faculty could be informed about the advantages that will help to both students and patients as a result of implementing the program in long term. The communication to the managements of different colleges must emphasize on the reducing hospital acquired infection, improved cleanliness and patient care, student satisfaction and recognition of the college.

To **conclude**, the program evaluation of BMWSP will be helpful to plan and improve the program and bring a change in the perception and behavior of the stakeholders. It will also help to reduce the incidence of HAI.

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Annexure- I: Table of Theories

Theory	Brief description	Key concepts	Strong points
Complexity Theory	This theory takes into account the non-linear interactions between different components of an open system that is often far from equilibrium.	➢ Systems are often open. ➢ An interaction between components is often non-linear and unpredictable. ➢ An entity within a system needs to be looked at in terms of its relation to other components and not in isolation.	➢ Emphasises on process Involved in program. ➢ Avoids over-simplification of complex phenomena. ➢ Ambiguity and uncertainty which are inevitable can be accommodated. ➢ Context is important in educational programs. ➢ Applied for retrospective analysis of the completed projects
Reductionism Theory	This theory assumes that an explanation for a complex phenomenon can be given if it is broken into its constituent parts. Each part can be investigated and its relationship to other parts can be defined along well defined linear pathways.	➢ Linear relationship between cause and effect ➢ Assumption of order ➢ Complex phenomena can be broken up into constituent parts	➢ Easy to understand ➢ Provides clear steps for implementation ➢ A strong theory for linear phenomena ➢ Theory suits for Laboratory experiments ➢ And Drug trials

Annexure II: Feedback Form for BMWSP

Please indicate your impressions of the items listed below.

Ratings:

1: Strongly Agree 2: Agree 3: Neutral 4: Disagree 5: Strongly disagree

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The training met my expectations.	❍	❍	❍	❍	❍
2. I will be able to apply the knowledge learned.	❍	❍	❍	❍	❍
3. The training objectives for each topic were identified and followed.	❍	❍	❍	❍	❍
4. The content was organized and easy to follow.	❍	❍	❍	❍	❍
5. The materials distributed were pertinent and useful.	❍	❍	❍	❍	❍
6. The trainer was knowledgeable.	❍	❍	❍	❍	❍
7. The quality of instruction was good.	❍	❍	❍	❍	❍
8. The trainer met the training objectives.	❍	❍	❍	❍	❍
9. Class participation and interaction were encouraged.	❍	❍	❍	❍	❍
10. Adequate time was provided for questions and discussion.	❍	❍	❍	❍	❍

11. How do you rate the training overall?

Excellent	Good	Average	Poor	Very poor
❍	❍	❍	❍	❍

12.Any suggestions for improving BMWSP:

13. Other comments:

Annexure –III: Objectives of BMWSP -Individual learner and Program Objectives

	Individual learner	Aggregate or Program
Learner		
Cognitive (Knowledge)	• By the end of the workshop each interns will be able to enlist the Bio-medical waste materials as per the Bins color code requirement. • Able to enumerate five points of advantages and disadvantages of Bio- waste segregation.	By the end of the workshop > 90% of interns will be able to enlist BMW material as per the color code of the Bins. >90% of the interns will be able to list five points of advantages & disadvantages.
Affective (attitudinal)	By the end of the workshop interns will rank BMW segregation as an important and effective intervention for controlling hospital acquired infection	By the end of the workshop there will have been a statistically significant increase in how interns rate the importance and effectiveness of BMW segregation by interns.
Psychomotor (skills or competence)	During the workshop , each interns will demonstrate at least once successful segregation of BMW material as per color code of Bins	During the workshop >90%of interns will have demonstrated successful segregation of BMW as per color code.
Psychomotor (behavioral or performance)	After the completion of the workshop, each intern will have negotiated the plan to segregate the BMW material according to the color code bins with >30% improvement from Baseline	By 2 months after completion of workshop there will be statistically significant increase in the percentage of interns who have negotiated a plan for segregating the BMW.
Process	Each intern will have attended all sessions of the BMWSEP	>90% of interns will have attended all sessions of the BMWSEP workshop.

Annexure –IV: Expected outcomes of BMWSP:

- to increase their awareness about BMWS
- Provide knowledge on the importance of BMW and BMWS
- Provide education and training on BMWS

Immediate outcomes of BMWSP:

- Participants will increase their knowledge and/or skills about BMWS
- All Dental Interns and HCW should be able to:
    a) Explain the importance of BMW Segregation.
    b) Segregate BMW into appropriate bins all the times.

Intermediate out comes:

- After the participants learn the need and importance of BMWS, they will apply the knowledge in their clinical practice.
- HCW will demonstrate improvements in the BMWS in the college and Hospital premises
- They will spread the knowledge through their college magazine, newsletters and conducting seminars.
- The interns will persuade and monitor the HCW in the BMWS
- A visible and measurable improvement in the BMWS in the college and Hospital premises

Long term outcomes:

- Participants will segregate BMW in real life situation all the times.
- Reduction in the incidence of HAI in the hospital and college.
- Dissemination of information of BMWS educational intervention program to other medical colleges affiliated to the University and hospitals in the State.
- Improving the health of the society

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