Welcome to Unit 15, “Economics of Infection Prevention.” In this lecture we will discuss the cost of hospital acquired infections (HAI’s), the financial benefits of infection control programs, and how to create a business plan for infection control. I would like to acknowledge Samantha Aylor, MSPH student, for her work in developing this unit and Miguel Reina, MD and PhD student for his work in fine-tuning this presentation.

As we have previously discussed, one of the major issues in the field of infection prevention is preventing hospital acquired infections (HAI’s). It is estimated that approximately 1 in 10 hospitalized patients will acquire an infection after admission. There are many different sources of HAI’s. If not used and cleaned properly, commonly used devices such as ventilators, central lines, and urinary catheters can cause infection in patients. Hospitals also harbor many multi drug resistant organisms like MRSA, VRE, and Clostridium difficile that can easily spread to patients. Surgical site infections are also potential sources for infection. Part of the information provided in this slide has been modified from the presentation “Building a Business Case for Infection Prevention” by Thomas Merkering of the Virginia Tech Carilion School of Medicine and Carilion Clinic.

This chart, which can be found in one of this week’s Required Readings, shows the number of HAIs by site of infection. Each year, there are approximately 1,737,125 HAIs reported in hospitals throughout the United States. Two of the most prevalent forms of infections are surgical site infections and catheter associated urinary tract infections. It is important for hospital epidemiologists to use surveillance methods to determine these numbers each year for their facility. This information can be used to help design effective programs to prevent these infections.

According to the CDC, the annual cost of HAIs in the United States is anywhere from $28.4 to $33.8 billion. The largest proportion of costs associated with HAIs is related to prolonged hospital stays. Patients who become infected have their hospital stay prolonged, during which time they occupy scarce bed-days and require additional diagnostic and therapeutic interventions. A large outbreak of HAIs in a facility can also lead to an increased need for medical staff, which can greatly contribute to overall costs.
When designing infection control programs, it is important to consider direct costs to the facility in terms of fixed and variable costs. Fixed costs are unavoidable short term costs. In terms of HAIs, these are the costs that most likely will not change by reducing HAI incidence. Fixed costs include long term contractual commitments, such as salaries, equipment lease agreements, and infrastructure costs. Variable costs are costs that may change during the short term, such as costs associated with medications, food, consultations, treatments, procedures, devices, testing, and supplies. When preventing HAIs, these variable costs often lead to cash-savings. For example, reducing patient time in the hospital reduces the amount of drugs and equipment needed for patient care and may reduce the need for certain medical staff. Researchers have found that 84%-89% of the costs of hospital care are fixed in the short term. Therefore, when considering the role of fixed costs in infection control, it is important to explore the value of the best alternative use of these resources. This value is known as the opportunity cost of the resource.

Although we will mainly focus on direct hospital costs in this lecture, it is important to consider other costs associated with HAIs. Indirect costs include lost wages and diminished worker productivity due to morbidity from HAI and possible funeral costs due to mortality. Family expenses should also be considered, including income lost by family members and money spent on hospital visits, travel costs, and home care. Intangible costs include psychological issues like anxiety, grief, and disability, as well as pain and suffering, and change in social functioning or daily activities.

Research has shown that infection prevention programs are extremely beneficial to many different healthcare facilities. Infection prevention programs can save a facility anywhere from $6.8 billion to $31.5 billion each year. In terms of prevented infections, it has been documented that these numbers translate to anywhere from a 20% to 70% decrease in HAIs. Effective prevention programs greatly reduce the length of hospital stays, which helps free up resources for alternative uses. Using these resources for alternative purposes often generates cost savings for the facility. Because infection control programs are costly themselves, it is important to compare the cost of the program with the savings generated. Most of the time the cost of prevention is much lower than the cost associated with treating HAIs.
One of the roles of an infection preventionist (IP) is to work with hospital administrators to determine how much to invest in an infection control program. The graph presented in this slide is a good model to use when determining how much to invest for infection control. The numbers used in these models are different for individual facilities and individual HAIs. In this example, the horizontal axis represents an incidence of hospital infections and the vertical axis represents cost and potential savings. We will discuss this graph in more detail throughout the next few slides.

This graph came from Nicholas Graves’ paper, “Economics and Preventing Hospital-Acquired Infection.” The reference for this article is listed below:


In this model, Line A summarizes the relationship between the cost and the effectiveness of infection control strategies. As you can see, when more resources are invested for prevention, the incidence greatly decreases. When considering how much to invest, you have to look at hospital surveillance data to determine the baseline incidence. You then must consider what is a reasonable financial commitment to reduce the incidence rate. In this graph, to achieve the low incidence of 0.01% requires an investment of $1.5 million; however, to reduce rates to only 5% requires a lesser investment of $393,661.

Line B1 represents the gross costs of hospital infection, i.e., the gross savings that would result from prevention. These costs and potential savings increase with incidence. The primary cost of hospital infection is the loss of bed-days due to prolonged length of stay. Care must be taken in valuing these bed-days and other resources used for hospital infection. For economic analysis, consider what else could be done with the resources released by prevention. A hospital in which rates of infection are successfully reduced will have more bed days available, so new patients can be admitted. The value of these new admissions to the hospital represents the gross costs of infection and, therefore, the potential gross savings from prevention.
So far we have restricted our discussion of the cost and savings from prevention to changes in the use of bed-days. We should also consider the financial expenditures made by the hospital. The financial expenditures on resources that represent fixed costs are largely irrelevant because they cannot be avoided in the short-term. What is even more relevant, are the variable costs that change in response to a decrease in the incidence of hospital infection. For example, patients who previously would have stayed for 15 days with a hospital infection now stay for only 10 and will incur lower variable costs. If the decrease in variable costs from reducing length of stay by 5 days is $100 per patient, then line B1 is too low an estimate of the costs of infection and potential savings. However, variable costs will also increase as a result of the increase in patient turnover. At rates of zero infection, hospitals are treating 2,500 more patients than before, and this will cause an increase in variable cost. For example, if the increase in variable cost is $750 per new admission, then this must be offset against the $100 per patient reduction in variable costs and the increase in revenue per case. The result is the net costs of infection and net savings from prevention and this is represented by line B2 in the above model.

Line C represents the total cost to the healthcare system and is the sum of Lines A and B2 for every incidence rate of hospital infection. For example, at an incidence of 9.00%, the net cost of infection is $1,582,536 (Line B2), and the cost of prevention programs is $132,088 (Line A). Line C represents the sum of these at an incidence of 9.00%, which equals $1,714,624.

In this model, the incidence of infection that minimizes total cost, indicated by Line C, is marked with an X. Achieving this incidence represents a rational goal for policy makers. Point X is a rational policy objective because, at this point, marginal savings exactly compensate the marginal investments in prevention. In contrast, investments that drive infection rates lower than point X are not adequately compensated.

We will now discuss the importance of creating a business plan for infection control and the steps involved in designing and implementing infection prevention programs.
When creating an infection prevention business plan, it is important to remember that infection control programs do not produce any revenue for the facility. Instead, they cost money. When presenting the business plan, IPs must demonstrate that although infection control programs are costly, they will eventually save money in the long term. Part of the information provided in this slide and the next 14 slides has been modified from the presentation “Building a Business Case for Infection Prevention” by Thomas Merkering of the Virginia Tech Carilion School of Medicine and Carilion Clinic.

Before presenting information to hospital administrators, IPs must first know the number and type of HAIs that are seen in their facilities. Once they have these numbers, they must then determine the attributable cost for each type of HAI. Sometimes attributable cost may be difficult to determine for certain facilities. In these cases, infection control literature can be used to help determine costs. It is also important to determine the payer mix, which classifies the different types of insurance accepted. This helps determine what insurance companies will contribute to cover the cost of HAIs. It is also essential to know how much third party payers will not reimburse. Finally, the IP must create a list of necessary supplies and determine the costs needed to carry out the infection control program.

The first step in developing an infection control business plan is to create a mission statement that embraces the use of cost-effective evidence-based practices to improve patient morbidity and mortality related to HAIs. The mission statement should effectively and concisely state what the aims and purposes of the program are. When creating a mission statement for an infection control program, it must be consistent and in line with the mission of your institution. It is important to keep it simple and defensible. The mission statement should serve as a “Constitution” for the program and one should be able to refer to this statement to help keep the program on track.

The second part of creating a business plan involves defining the problem and developing hypotheses about potential solutions. In this case, the problem is HAI’s and their economic burden on healthcare facilities. It is important to concisely state this problem and determine which interventions are necessary to reduce the problem. Use both in-house data and supporting data from the literature to demonstrate the financial burden of HAI’s and determine what the necessary resources are to prevent them. It is then important to create a budget based on these findings. We will discuss budgets in more detail in Part II of this unit.
3. ENGAGE ADMINISTRATORS
- Discuss the initial plan with hospital leaders
  - Director of Quality Improvement
  - Chief Medical Officer
  - Chief Financial Officer
  - Others a per your institution’s hierarchy

4. CALCULATE ANNUAL EXPENSES
- Personnel costs
- Equipment
- Software programs
- Space
- Supplies
- Communications
- Education

5. DETERMINE THE PREVALENCE OF HAI & WHICH ONES CAN BE TARGETED
- Use surveillance data to determine the number of HAIs in each category
  - Device infections, MDRO, SSI
- Decide what you are going to target

6. CALCULATE COSTS ASSOCIATED TO THE HAI’S OF INTEREST
- Determine costs associated with each type of HAI
  - Surveillance Data, Literature & Software
- (# of infections reduced) x (associated cost) = Savings

7. ESTIMATE FINANCIAL IMPACT
- Calculate financial impact for each type of HAI
- Calculate in three ways
  - Mean
  - Low end attributable cost
  - High end attributable cost
- Subtract the costs of the program
  - Result = Anticipated Savings

Once you have developed a mission statement, defined the problem, and determined appropriate infection control strategies, it is important to then take your findings to the key administrators in the facility. It is important to discuss the initial plan with the Director of Quality Improvement, the Chief Medical Officer, and the Chief Financial Officer as well as any other pertinent persons according to your institution’s hierarchy. The purpose of this meeting should be to obtain agreement that HAI’s are of institutional concern and to gain the support of hospital leadership. During this meeting, you should learn who else can be a key player and who should be included in developing the business plan. This is a good opportunity to also discuss other costs that should be considered.

After discussing the initial business plan with hospital administrators, IPs must then determine the annual costs that are necessary to carry out an infection control program. These include personnel costs, equipment costs (i.e. computers, copiers, fax machines), software programs, office space, supplies, communication costs, and education costs. We will discuss these in more detail in the budget lecture in Part II of this unit.

Step 5 should be to determine the prevalence of HAIs and which ones should be targeted. Using surveillance data, IPs can determine the number of infections seen in a certain facility in each category (i.e. device infections, multiply drug-resistant organisms [MDROs], and surgical site infections [SSIs]). After analyzing these data, it is important to then determine which infections are the most prevalent and which ones can be reduced using cost effective methods.

The next step in developing a business plan is to determine the costs associated with the infection of interest at your hospital. Costs can be determined using in-house surveillance data, literature resources, and some software companies. The gross cost associated with infection is represented by Line B1 in the infection control investment model. This data can be used to show that increased incidence of infection causes increased costs to the hospital. Therefore, preventing these infections will save the facility money. The amount of savings can be determined by multiplying the number of infections that can be reduced times the associated cost of an individual infection.

The next step in developing the business plan involves calculating the overall financial impact of HAIs including the savings generated from an infection control program. These data should be presented in three different ways: using the mean and a range that is represented by the low end attributable cost and high end attributable cost.
**Slide 24**

**Determining HAI Costs**

- Must use attributable costs
- **Example:** If a particular HAI costs $25,000, the hospital does not necessarily lose $25,000 for each infection.
- Important to factor in the payer mix & the percentage reimbursed to determine attributable cost.

Determining HAI costs can be tricky and many factors have to be considered. Once the gross cost of infection is determined, it is important to consider all other factors and determine attributable costs. For example, if the cost of a particular HAI is $10,000, the hospital does not necessarily lose $10,000 for each of these HAIs. It is important to also factor in the payer mix and the percentage that is reimbursed from other third parties to determine the attributable or net costs.

**Slide 25**

**EXAMPLE**

- Cost of VAP = $50,000 per infection
- Cost of ICP = $100,000
- Goal = Prevent 10 VAPs

- **Bad Logic:**
  10 infections x $50,000 = $500,000. If 10 infections are prevented the hospital will save $400,000 ($500,000 - $100,000)
  - Savings might actually be lower

In this example, assume that the cost of a ventilator-associated pneumonia (VAP) is $25,000. In your plan you have decided that you will prevent 10 of these infections. The incorrect logic is the calculation that 10 x $25,000 = $250,000 and since your program costs $80,000, the hospital saved $170,000. When other factors are considered, the savings is actually much lower. For example, if the profit from a patient on a ventilator is $10,000, but with an identical patient with a VAP this number falls to $1,000 due to a mix of reimbursements, the savings per VAP prevented is $9,000, not $25,000. The total amount for ten patients is $90,000 and your program costs $80,000. Therefore, the real savings for the hospital is only $10,000. This adjusted cost is represented by line B2 of the investment model.

**Slide 26**

**8. MAKE YOUR CASE**

- Do NOT present to key administrators straightaway
  - Discuss with middle-ranks
  - Build consensus
  - Get ideas

Once all the data have been collected and all the attributable costs and savings have been calculated, it is then important to make your case. Present the data to unit managers first before presenting to hospital administration. This will allow you to build a consensus and give you time to tweak any mistakes that were made. Presenting to other people first also helps provide you with good ideas for the actual implementation of your plan. Once you have a good consensus, then present your business plan to key administrators. Although hospital administration is concerned with keeping patients safe, they are limited by funding. Therefore, it is important to focus on how your plan will save the hospital money rather than focus on patient benefits. It is also important to place emphasis on your collected data to back up your ideas.

**Slide 27**

**9. COLLECT COST & OUTCOME DATA CONTINUOUSLY**

- Needed to show intervention impact
- Administrators want to see that HAI prevention programs are saving the facility money

Once hospital administrators have approved an infection control business plan, it is imperative to continue surveillance efforts to document the incidence of HAIs and their associated costs. A common problem for IPs is that when infection control plans are implemented, they often have to face budget cuts in the future. When HAIs become low, the rate of savings return lessens and administrators often decide to use money in alternative ways. It is important to continue collecting data to show what could happen without a continued program.
### Slide 28
**Economic Evaluations**
- **Cost-effectiveness analysis**
  - Compares interventions with different costs & levels of effectiveness
- **Cost-utility analysis**
  - Benefits are adjusted or weighted
- **Cost-benefit analysis**
  - Valued in monetary or dollar terms

There are several different ways to evaluate cost and outcome data during implementation of an infection control plan. The first commonly used method is a cost-effectiveness analysis. This type of analysis compares interventions that have different costs and different levels of effectiveness. The benefits of an intervention are measured, such as the number of lives saved or infections prevented. Programs are then compared in terms of cost per unit (e.g., dollars per life-year gained or dollar per infection prevented). The next type of analysis is a cost-utility analysis, in which specific interventions are adjusted by health preference scores or are utility weighted. In this type of analysis, programs are compared in terms of quality-adjusted life years (QALYs) gained. In a cost-benefit analysis, all aspects of the analysis, including the consequences of the intervention, are valued in monetary or dollar terms. If an intervention’s benefits measured in dollars exceed its costs, then this analysis considers it worthwhile. The major impediment to the use of cost-benefit analysis in healthcare decision making is the requirement to set a monetary value on human life or health benefits.

### Slide 29
**Useful APIC Tools**

On the APIC website, there are two healthcare-associated infection cost calculators. These are freely available on-line at the link listed on this slide and in the transcript: [http://www.apic.org/Resources/Cost-calculators](http://www.apic.org/Resources/Cost-calculators) These may be useful when developing your Infection Control Business Plan. You are encouraged you to download them and practice using them.

### Slide 30
**Summary**
- HAIs cost hospitals billions of $$ each year
- Infection prevention programs save $$$$
- Investment models helpful when determining how much to invest in IC programs
- Infection control business plans should focus on cost efficiency
- There are several important steps to creating an effective business plan
- Cost & outcome data should continue to be collected after implementing a program

In summary, HAIs cost hospitals billions of dollars each year and infection prevention programs have been very successful at saving facilities money in the long term. When determining how much to invest in infection control programs, it is important to collect both in-house and literature data to create an investment model. This model will be helpful in setting realistic infection prevention goals. There are several important steps to creating an effective business plan and it is important to focus on cost efficiency and raw data. Also, cost and outcome data should continue to be collected after implementing a program.

**This concludes Unit 15, Part I.** Please view Unit 15, Part II to learn how to create an infection control budget and to complete Assignment #9.