ASPR TRACIE Emergency Preparedness Information Modules for Nurses in Acute Care Settings

August 2019

The U.S. Department of Health and Human Services Office of the Assistant Secretary for Preparedness and Response (ASPR) Technical Resources, Assistance Center, and Information Exchange (TRACIE) partnered with Spectrum Health to evaluate a series of healthcare emergency preparedness information modules for nurses (EPIMN) in acute care settings. To complement this effort, ASPR TRACIE also engaged a senior health economist to construct a framework to assess the impact and outcomes associated with implementing training programs like EPIMN.

Research has shown that nurses generally lack a foundation of emergency preparedness and response knowledge.[1, 2, 3] Spectrum Health surveyed its nurses and found a similar knowledge gap within its health system. To address this need, Spectrum Health developed information modules for its acute care nursing staff. ASPR TRACIE engaged its Subject Matter Expert (SME) Cadre to review the information modules, adapted the modules for application to acute care settings generally, and disseminated EPIMN for potential use by healthcare facilities nationwide. A case study describing the roll-out of EPIMN by Spectrum Health and the effects of implementing the training program among its acute care nurses is included as Appendix A.

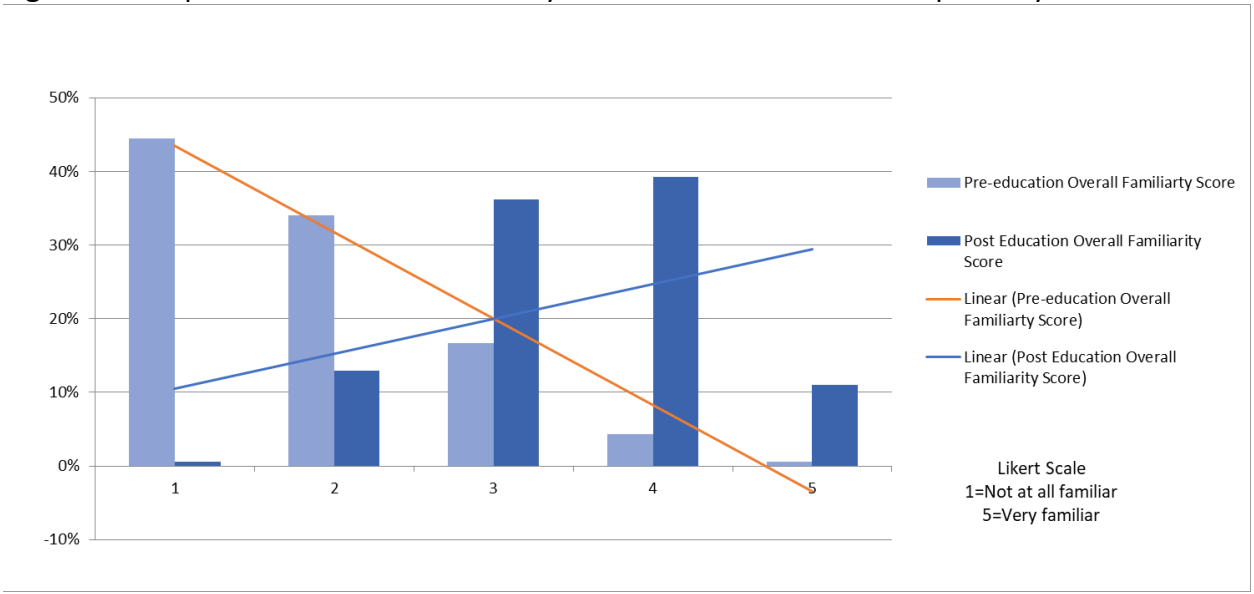
Complementing the efforts to develop and make EPIMN available, ASPR TRACIE also supported a senior health economist in developing a framework that healthcare organizations may use to conduct an economic analysis of the costs of providing initial and refresher preparedness training to their personnel and the associated gains to measure the return on investment (ROI) of such training. The senior health economist used Spectrum Health and its implementation of EPIMN as a case study for application of this framework. A summary description of the development of the framework is included later in this document and the full report is included as Appendix B. The senior health economist also developed an EPIMN ROI Calculator that allows ASPR TRACIE stakeholders to estimate their own ROI.

EPIMN Background

Previous studies have shown a general lack of foundational emergency preparedness and response knowledge among nurses, who are expected to play a critical role during a healthcare disaster response or public health emergency. In 2018, Spectrum Health conducted a survey of more than 5,000 nurses across its health system to examine their perceived overall familiarity with emergency preparedness and disaster response. Among the 16% who completed the survey, 78% documented little or no familiarity. To address this knowledge gap, Spectrum Health planned a multi-phase project to: 1) develop information modules for their acute care nursing staff, 2) deploy the curriculum to acute care nurses across the Spectrum Health system, and 3) resurvey nurses to determine whether the education modules improved their familiarity with emergency preparedness and response. A case study detailing the Spectrum Health experience is included as Appendix A.

Spectrum Health developed six information modules on a variety of emergency preparedness and response topics relevant to nurses working in acute care settings. Spectrum Health resurveyed its nursing staff after they completed the information modules to validate the effectiveness of the curriculum in improving perceived knowledge of emergency preparedness and response topics. Figure 1 shows the overal familiarity score comparing results from the initial survey with those from the survey following completion of the information modules.

Figure 1. Comparison of Overall Familiarity Score on Initial and Follow-up Surveys



Members of the ASPR TRACIE SME Cadre reviewed the draft curriculum content, referred to as EPIMN, to assess its accuracy and applicability to healthcare personnel who do not work in emergency departments or emergency services on a daily basis, but may become involved in emergency incident response. Based on SME feedback and the need for the curriculum to be applicable to other health systems and jurisdictions, ASPR TRACIE modified some portions of EPIMN from the original Spectrum Health modules. Modifications included: generalizing some content to broaden its applicability outside Spectrum Health; incorporating lessons from recent no-notice, dynamic, mass casualty incidents with exceedingly large numbers of patients; and combining concepts from Modules 4 and 5 of EPIMN into a single infection control and prevention module, thereby reducing the total number of modules from six to five. These five modified modules are what ASPR TRACIE has made available to health systems nationwide.

EPIMN

The following five information modules comprise EPIMN and are available for download:

Module 1: Mass Casualty Incident (MCI) Response

Module 1 educates staff on mass casualty triage, preparing for and assessing an incident, and identifying patient needs. It identifies the types of MCI notifications and how a healthcare facility may assist the MCI response. The module defines MCI triage and highlights special considerations for pediatric patients. It describes the various evidence-based triage and

assessment tools used in the U.S. It also provides information on patient identification and handling the deceased. The module concludes with an overview of chemical, biological, radiological, nuclear, and explosives (CBRNE) exposure strategies.

Module 2: Understanding the Incident Command System

Module 2 focuses on the Incident Command System (ICS). It defines ICS, when it should be implemented, and how it is applied in hospitals. The module describes each of the functions within the ICS structure and emphasizes the importance of using plain language and a common terminology under chain of command and unity of command. The module also describes four phases of emergency management and identifies components to include in emergency operations plans.

Module 3: Accessing Critical Disaster Resources

The focus of Module 3 is awareness of available resources and how to obtain them. It identifies internal resources, including a hospital decontamination team, emergency preparedness team, emergency operations plan, personal protective equipment, and hospital command center. It also describes potentially available external resources, including disaster funds, the Strategic National Stockpile, CHEMPACK, the National Disaster Medical System, and Chemical Hazards Emergency Medical Management. Other topics include the use of volunteers and a summary of CBRNE agents.

Module 4: Infection Control and Prevention

Participants will learn more about infection control and prevention for emergency situations in Module 4. It defines communicable diseases and offers examples, identifies risk factors for contracting a communicable disease, and lists protocols to prevent exposure risk. The module addresses safety measures to protect staff, including the use of standard precautions and personal protective equipment. It lists symptoms often associated with communicable diseases, possible modes of transmission, and reportable disease procedures. Additionally, it provides specific details on dealing with Ebola virus disease and other special pathogens, including a description of the tiered, national system created for the management of confirmed patients.

Module 5: Internal and External Communication During a Large-Scale Event

Module 5 spotlights the importance of effective communication during a disaster. It defines communication, situational awareness, and collaboration. It stresses the importance of plain language use and identifies communication barriers. The module outlines the elements of an emergency contact checklist and describes formal and informal information sharing protocols and tools, both internally and with external partners.

Each module contains questions throughout to test knowledge. All modules conclude with a list of references.

Should you wish to modify the content included in the EPIMN for implementation to suit your own healthcare facility, please contact ASPR TRACIE at askasprtracie@hhs.gov to request editable PowerPoint files.

ROI Framework for Training Programs

Given limited resources, organizations must make choices between competing projects because resources dedicated to one project cannot be used for another. Return on investment (ROI) estimation facilitates these decisions. An organization considering the purchase of a business can use the ROI methodology to determine if the investment it must make to purchase the business is expected to generate returns in excess of its costs. In this case, the investments and expected returns are generally known. In other instances, such as determining the ROI of a training program, expected returns may have substantial uncertainty. Accordingly, this report provides a methodology for ROI estimation for training programs and applies it to EPIMN. Appendix B includes complete details of this methodology and its application to EPIMN.

ROI Estimation Framework

Estimating the ROI of a training program requires accounting for both costs and gains (returns). Training program costs may include program development costs, preceptor costs or information technology hosting costs, and program update costs, but the most substantial costs are generally the value of trainees' time to take the training and any refresher training. Estimation of gains requires accounting for their inherent uncertainty. This stems from variation in both the probability that an event will occur for which the training is relevant and the expected gains from the training. Note that only costs and gains borne by the organization are relevant to the ROI as the organization needs to understand its specific returns.

Event probability. The gains of a training program need to account for the probability that an event the training is designed to address will occur. If it is a rare event, a period of several years should be used to estimate the event probability so that an unusually high or low occurrence rate in a single year will not bias the results.

Expected gains. Estimating the gains associated with a training program is less straightforward than estimating its costs. To identify the potential gains of a program, consider the program's objectives. Viewing potential gains through this lens may naturally identify gains. Conceptually, training is unnecessary if there is no problem to solve. If on point, the training will solve or at least mitigate the problem it is designed to address. On this basis, the gain is the expected value the organization realizes from addressing the problem and should naturally point to how to measure it.

Some gains will be quantifiable and others will not. For an ROI evaluation, consider quantifiable gains as those that can be monetized. At a minimum, measurable gains should offset the costs. While some gains are not quantifiable, it is helpful to document them as well as possible so that, if the measurable ROI is just below or just above the break-even point, decision-makers can consider the non-quantifiable gains to inform their decision about whether to proceed with the training program.

Sensitivity analysis. Unless the training program is well-established or has many similarities to other established training programs, one will not actually know what the gains will be a priori given uncertainty. Hence, a sensitivity analysis can aid decision-makers as they decide whether

to make the training investment. For each of the key assumptions used in estimating the gains, ROI evaluators can vary these values to see how sensitive the finding of a positive ROI is to the changes in each. The sensitivity analysis should focus on showing the consequences to the ROI when results fall short of expectations. If an organization still finds a positive ROI under more conservative assumptions, that provides more confidence that the training program will actually result in a positive return.

ROI Case Study: EPIMN

This section applies the ROI estimation framework to EPIMN. Because EPIMN is designed to help hospitals be better prepared to handle an emergency incident, we measure ROI from the perspective of a representative or average hospital. Based on data from the American Hospital Association and the Bureau of Labor Statistics, the average U.S. hospital has 150 staffed beds and 273.5 RNs.

Event probability. We have estimated the event probability to include MCI and infectious disease outbreaks. MCIs would include natural disasters (e.g., earthquakes and wildfires); extreme weather events (e.g., hurricanes); and violence (e.g., terrorism, mass shootings, and non-gun violence with mass casualties). Infectious disease outbreaks would include novel pathogens like Zika and Ebola, for example. Because the number and impact of emergencies varies greatly year to year, we estimated event probability using a 5-year period to minimize the potential bias that would be associated with using the history of a single year that may substantially differ from the long-term average.

Based on public health emergency declarations in combination with MCIs stemming from gun and non-gun violence, for the purposes of this cost study, we estimate that 2.09% of U.S. hospitals (1 in 47.9) are affected annually, with public health emergencies affecting 1.75% of hospitals and violent events affecting 0.33%. It is likely that the 2.09% value is an underestimate, given that we did not include all contingencies such as cyberattacks or utility failures.

Costs. The most significant cost is the value of trainees' time to take the original and refresher training. Other costs to develop and host the training are not borne by the hospital so they are not considered in the ROI. Data from Occupational Employment Statistics and the Bureau of Labor Statistics show that the average hourly wage of hospital RNs is $38.15 in 2019 dollars and $48.51 when benefits are included. Total training time for the five modules (0.3 continuing education credits each) is 1.5 hours. On this basis, the initial year training costs for a representative hospital are $19,906.

We assumed that RNs would receive 0.75 hours of refresher training every other year and that RNs new to the hospital (due to natural staff turnover) would receive the original training. Accordingly, we estimate that the annual cost in subsequent years would be $7,058. Note that the assumed bi-annual refresher training (at one-half the length of the original training) does not account for other continuing education that nurses may require, but focuses solely on the EPIMN training needs.

Quantifiable gains. The expectation is that EPIMN will result in both quantifiable and non-quantifiable gains. The gains we have quantified are the reduced costs associated with RN turnover and the hospital cost inefficiencies associated with RN turnover. There is a broad literature on the cost of RN turnover.[4, 5, 6, 7, 8, 9, 10] Across this literature, average RN turnover costs are 68% of RN salary, but estimates vary widely from 40% to 130% of salary.

As this is a prospective analysis, there are no specific estimates for how much RN turnover EPIMN will prevent. Overall RN turnover in the United States averaged 16.44% over the 2014-2018 period, but turnover varies by nurse specialty.[i] If we assume that the difference in turnover for critical/intensive and emergency/trauma care nurses compared to all other nurses is representative of the turnover that could be avoided by EPIMN should an emergency event occur, we can use this differential to estimate EPIMN's turnover impact. The RN turnover rate for critical/intensive and emergency/trauma care nurses is 18.22% annually compared to 15.60% for all other nurses. This is a difference of 2.62 percentage points, which we have used to estimate the turnover impact (this estimate is comparable to other training and RN turnover studies).[11, 12]

As for hospital cost inefficiencies associated with RN turnover, Bloom[13] found that a 1-percentage-point increase in RN turnover was associated with a 0.11% increase in personnel costs and a 0.17% increase in non-personnel costs. For a 2.62-percentage-point increase in RN turnover, non-RN personnel costs increased $58,746 and non-personnel costs increased $186,823 for the average hospital. As Table 1 shows, expected annual gains from EPIMN are $13,275 given the turnover impact and an event probability of 2.09%.

Table 1. Annual gains from training

	All RNs
Avoided RN turnover costs	$8,143
Avoided increase in non-RN personnel costs	$1,228
Avoided increase in non-personnel costs	$3,905
Total gains	$13,275

ROI estimate. We estimate that the EPIMN will have a positive ROI in the fourth year. By the tenth year, the total ROI is 40.1% or 3.4% on a per annum basis (Table 2). These ROI values assume initial training costs of $19,906, subsequent annual costs of $7,058, and annual gains of $13,275. Hence, after the initial year, the annual net gain is $6,217 (13,275 – 7,058), but given the size of the initial investment, it takes 4 years to recover that investment.

Table 2. Percent ROI by year

Year	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Overall	-51.4	-23.7	-5.7	6.8	16.1	23.2	28.7	33.3	37.0	40.1
Per year	-51.4	-12.6	-1.9	1.7	3.0	3.5	3.7	3.7	3.6	3.4

[i] Based on data from Nursing Solutions, Inc., *National Health Care Retention & RN Staffing Report*, various years.

Sensitivity analysis. Because EPIMN is new, its cost effectiveness is unknown. The estimated ROI is based on the best available information. Given the uncertainty, we examined how sensitive the result of a positive ROI is to the key assumptions. The three most critical assumptions are the event probability, the impact on RN turnover, and the cost of RN turnover. We found that the event probability could decrease 28% from our best estimate of 2.09% to 1.50% and still break even after 10 years. Similarly, the impact on RN turnover could decrease 28% from our best estimate of 2.62% to 1.88% and still break even after 10 years. Additionally, we found that the estimated cost of RN turnover could decrease from 68% to 37% of RN salary and still break even in the tenth year.

Non-quantifiable gains. The preceding ROI analysis included only the gains that could be monetized. To the degree that there are non-quantifiable gains, the analysis has underestimated the ROI. The literature shows that these non-qualifiable gains include the impact of RN turnover on quality of care for patients and patient satisfaction[14, 15, 16, 17] as well as benefits for nurses.[18, 19, 20]

Summary

ROI estimation is challenging for investment decisions in training programs where the gains of the program are not well-defined. Evaluation of the ROI for EPIMN showed a positive ROI by the fourth year. As estimated gains depend crucially on some key assumptions, we evaluated the sensitivity of the ROI estimates for changes in these assumptions. Baseline assumptions were best estimates based on the literature and existing data. The results show that even when substantially more unfavorable values are used for key assumptions, the ROI of EPIMN broke even by the tenth year.

EPIMN ROI Calculator

To assist other healthcare systems in estimating the ROI of providing training based on EPIMN to their acute care nurses, ASPR TRACIE offers the EPIMN ROI Calculator. This tool uses the default values described in the ROI framework for a representative hospital as inputs. The Calculator outputs include initial and subsequent year training costs, expected yearly gain, and ROI by year for 10 years. Users also have the option to input alternative values based on their hospital or healthcare facility's data to calculate results more representative of their situation.

Conclusion

In 2018, Spectrum Health found significant gaps in preparedness knowledge among nurses who completed the EPIQ survey, a finding consistent with what had been documented in other healthcare systems. Spectrum Health identified six information domains of the EPIQ survey that had the most significant impact on their nurses' preparedness knowledge. Recognizing that nurses in other health systems may have similar knowledge gaps, ASPR TRACIE and their SME Cadre supported Spectrum Health in developing EPIMN, a training program that could be shared for adaptation by hospitals nationwide. Spectrum Health nurses who completed all EPIMN modules demonstrated significant improvements in their preparedness knowledge.

ASPR TRACIE also engaged a senior health economist to develop an economic framework to allow health systems to measure their ROI in training programs. Using EPIMN as an example of a training program in a representative hospital, the model estimated a positive ROI of EPIMN in the fourth year of implementation. Even when using far less favorable assumptions, the ROI of EPIMN broke even by the tenth year. These results suggest that hospitals and health systems that offer EPIMN will see improvements in the preparedness knowledge of their nursing staff as well as a positive return on their investment in the training program. To more closely estimate the ROI of a specific hospital or health system rather than a representative hospital, the EPIMN ROI Calculator allows users to input their own data and view their training costs and ROI by year.

All healthcare workers need some level of emergency preparedness training. A variety of resources currently exist – ranging from Federal Emergency Management Agency incident management training to Basic and Advanced Disaster Life Support courses to infection prevention and control certification – that address various issues that may arise during a healthcare emergency. The modified EPIMN is one option that healthcare facilities may wish to consider, particularly for their acute care nurses. Those who do use the modules should further modify them as necessary to reflect the specific needs of their facility and its role in overall emergency response in their community. Because the EPIMN content is tailored to nurses in acute care settings, users should also modify the modules when implementing training programs for nurses in other other settings and for other types of healthcare workers.

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Appendix A: Case Study of the Spectrum Health Experience

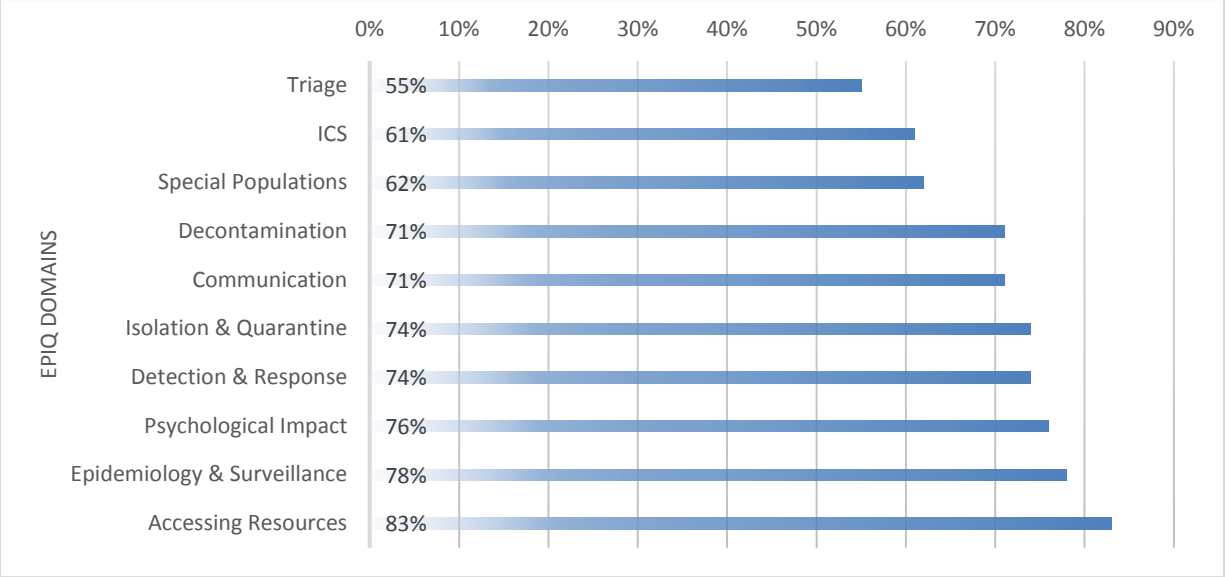
As the Spectrum Health system conducted after action reviews of exercises and incidents, they identified a gap in emergency preparedness and response knowledge among nurses. Reviewing the current literature related to nursing foundational knowledge of healthcare emergency preparedness and response, the results supported the identified Spectrum Health gap and conclusion that Spectrum Health nurses were inadequately prepared and therefore not feeling confident in their ability to respond effectively to a disaster situation.[1, 2, 3, 4]

Spectrum Health had already determined education was going to be a strong focus for the upcoming fiscal year. Based on the after action reviews and the current literature, Spectrum Health designed a four-part project to include:

1. A literature review identifying a valid and reliable survey tool for emergency preparedness and response;
2. Distribution and statistical analysis of the survey;
3. Development and distribution of education modules based on the results; and
4. Performing a resurvey of those completing the modules to determine any significant impact on overall preparedness knowledge.

The project began in 2018 with the initial survey of approximately 5,000 registered nurses working within the Spectrum Health system. The survey tool utilized (with permission from the author) was the Emergency Preparedness Information Questionnaire (EPIQ).[5] The EPIQ tool has been used in several studies, indicating strong reliability and validity.[6, 7, 8, 9, 10, 11, 12, 13] The original survey results from Spectrum Health were as expected and documented a very low perceived familiarity with emergency preparedness and response knowledge (78% of those responding recorded a 1 or 2 on the 5-point Likert scale – little to no knowledge). The EPIQ survey contains questions within 10 domains of emergency preparedness and response. Figure A1 shows the percentage of nurses who reported no or little knowledge in each of the 10 domains. The statistical analysis of the original survey identified six domains having a significant impact on the overall familiarity question results ($p<0.0001$ – $p=0.0195$).

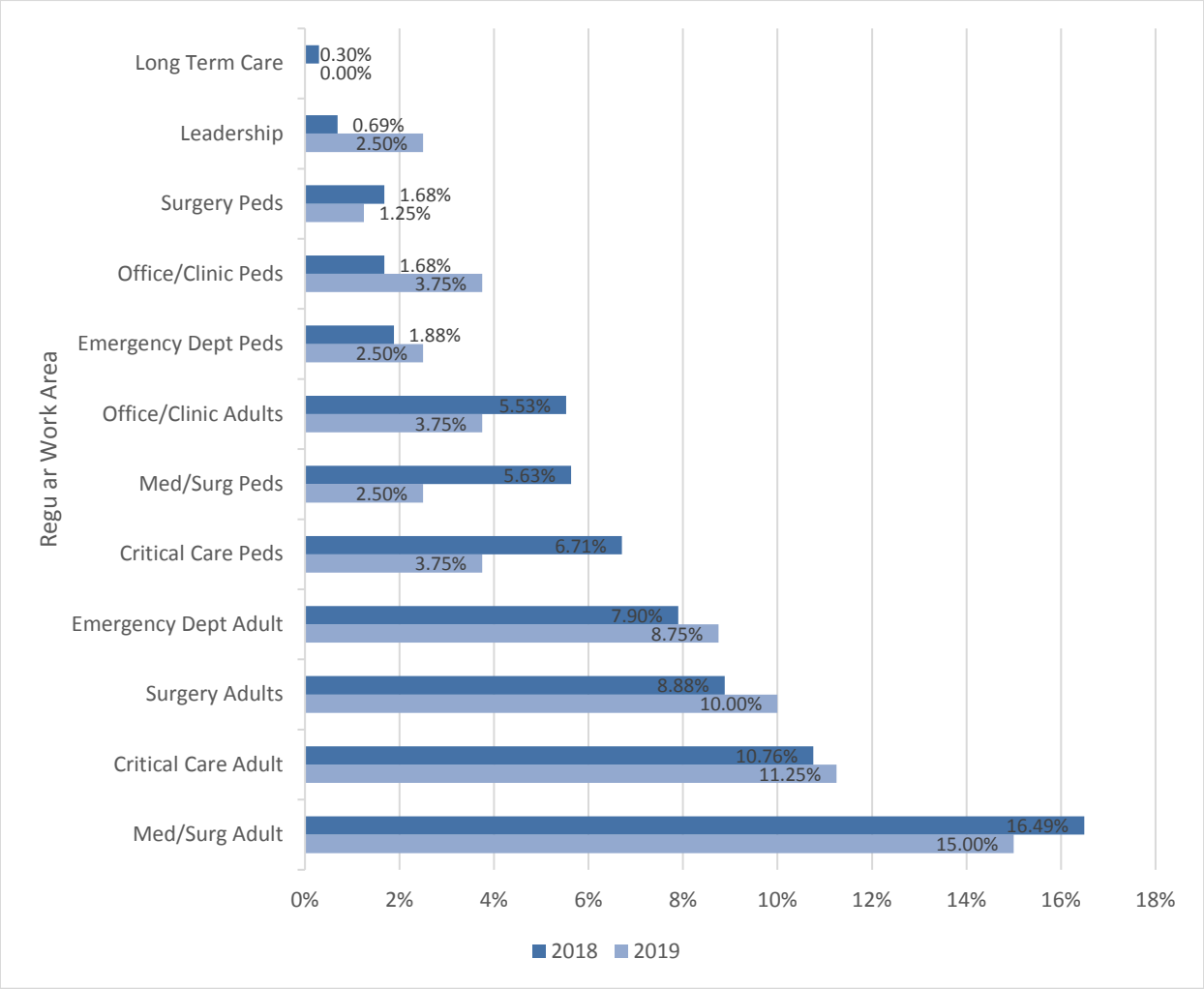
Figure A1. Percentage of Nurses Who Recorded 1 (No Knowledge) or 2 (Little Knowledge) by EPIQ Domain



Information modules focused on the six domains identified as significant (Triage, Incident Command System [ICS], Communications, Detection, Isolation and Quarantine, and Resources) were developed by Spectrum Health with support from ASPR TRACIE. Working with the education department at Spectrum Health, 0.3 nursing credits were applied to each individual module and the modules were packaged as a curriculum on the Spectrum Health System online learning institute. An invitation email was distributed to the original survey group, allowing them one month to complete the six modules.[i] Of the original survey group, 395 nurses registered for at least one of the modules; 342 completed at least one of the modules; and 258 completed all six modules by the deadline. Spectrum Health then distributed a follow-up survey to the 258 nurses who completed all six information modules. These nurses were allowed one month to complete the follow-up survey. Figure A2 compares the percentage of nurses who completed the original 2018 survey and the follow-up 2019 survey by their regular work area.

[i] Note that while Spectrum Health developed six modules for their nursing staff based on the EPIQ domains, the modified EPIMN offered through ASPR TRACIE contains five modules.

Figure A2. Percentage of Nurses Who Completed Original and Follow-Up Surveys by Work Area



The results of the follow-up survey demonstrated a significant impact on the overall familiarity question. A total of 163 nurses completed the survey (63%). The statistical analysis (Chi-square) compared the 2018 results for the overall familiarity question (Question 45[ii]) to the 2019 results. The outcome of that analysis was significant (p=<0.0001), documenting an improvement of perceived knowledge related to emergency preparedness and response of the staff completing all six modules and the post education survey. Further analysis was completed comparing the 2018 and 2019 levels of Likert scale response. As evident in Table A1, Question 45 responses at all levels of the Likert scale from 2018 to 2019 documented a statistically significant improvement post education module completion.

[ii] Question 45 of EPIQ is as follows: "Please provide an assessment of your OVERALL FAMILIARITY with response activities/preparedness in the case of a large-scale emergency incident." Response is on a Likert scale of 1-5 with 1 being "not at all familiar" and 5 being "very familiar."

Table A1. Comparison of overall familiarity Likert scale responses

	1		2		3		4		5	
Year	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
2018	44	97.78	34	72.34	17	32.08	4	9.30	1	8.33
2019	1	2.22	13	27.66	36	67.92	39	90.70	11	91.67
P-value	<0.0001		0.0011		0.0045		<0.0001		0.0019	

Based on the success of this project, Spectrum Health System will develop and upload modules on additional EPIQ domains to its online learning institute. After publication of all modules, Spectrum Health System will implement an internal marketing strategy ensuring awareness of the EPIMN educational opportunity, focusing on a specific topic each month. Anticipated follow up includes future surveys providing a better understanding of the frequency of refresher educational opportunities.

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Appendix B: Economic Framework for Determining Return on Investment for Training Programs

Introduction

Given limited resources, organizations must make choices between competing projects because resources dedicated to one project cannot be used for another. In other words, the opportunity cost of resources means that the expected return from any specific investment must be considered relative to alternative investments. Return on investment (ROI) estimation facilitates these decisions. Without any discounting of future values, ROI is defined as:

$$ROI = \frac{Returns}{Investments} = \frac{Gains - Costs}{Costs}.$$

Generally, there are upfront investments to realize future returns (i.e., future gains less any future costs). Because resources have an opportunity cost, future returns are compared against the expected returns the organization would realize on alternative investments. This opportunity cost is measured as the cost of capital, which ROI analysis uses to discount future returns relative to the initial costs. Hence, if there is a positive discounted ROI, the organization's expectation is that the project is more beneficial than its opportunity cost.

Mathematically, ROI calculations are straightforward. For example, an organization considering the purchase of a business can use the ROI methodology to determine if the investment it must make to purchase the business is expected to generate returns in excess of its opportunity cost. In this example, the investments and expected returns are generally known or at least have minimal variation. In other instances, expected returns are unknown and/or have substantial variation. In these cases, there is less precision in the ROI estimate, such as when determining the ROI of a training program.

While the costs associated with the development and running of a training program may be known, gains are not. Identifying and estimating gains can be challenging since they are not well-defined and because some gains may not be quantifiable. Estimating the ROI of a training program is also complicated to the degree that some costs or gains are external. Accordingly, such an ROI evaluation needs to carefully consider who bears the costs and who realizes the gains as accurate ROI estimation requires alignment of costs and gains to the specific organization in question.

Given the challenges of estimating ROI for training programs, the purposes of this report are to (1) detail a conceptual methodology for ROI estimation in the training context, and (2) use a case study to provide an example of ROI estimation for a specific training program. This case study is for the Emergency Preparedness Information Modules for Nurses (EPIMN), which targets registered nurses (RNs) to improve familiarity with emergency and disaster response.

ROI Estimation Framework

Estimating the ROI of a training program requires consideration of the following: unit of measurement, probability of event occurrence that the training is designed to address, costs associated with the training program, quantifiable and non-quantifiable gains associated with the training program, cost of capital, and sensitivity analysis. While ROI is mathematically unambiguous, its inputs may be uncertain with substantial variation. Hence, ROI estimation needs to detail input variability and provide a means to evaluate the sensitivity of ROI estimates to input values.

Unit of Measurement

If an organization is going to invest in a training program, it needs to know its expected return from this investment. It may be that the organization does not bear some costs or that some gains of the training flow to external groups. That is not to say that these external costs and gains are unimportant, but in terms of an organization-centric investment decision, they are not relevant.

Among non-government community hospitals, 69% are not-for-profit hospitals.[1] Given that not-for-profit hospitals (with presumably altruistic motives) dominate the hospital industry, one may question the organization-centric nature of this ROI methodology and allow for external gains. While not-for-profit organizations do not distribute their positive operating margins, they still require a positive operating margin to remain financially viable. Without financial viability, they have no long-term ability to meet their altruistic aims. Consequently, it is important to isolate costs and gains specific to the organization in question. Similar arguments would apply to government hospitals who are responsible to taxpayers for efficient resource use.

While this organization-centric approach for ROI estimation is essential, it is still valuable to identify and document external costs and gains for context. For example, documenting external gains would allow an organization to show any benefits it provides to the community at large, but these should not be included in the ROI calculation.

Event probability

The benefits of a training program need to account for the probability that an event the training is designed to address will occur. If it is a rare event, a period of several years should be used to estimate the event probability so that an unusually high or low occurrence rate in a single year will not bias the results.

Costs

The ROI calculation needs to identify all costs the organization will incur in developing and administering the training program. These costs may include the following:

- Training program development costs
- Cost of preceptor time or information technology costs to host the training

[1] American Hospital Association, *Fast Facts on U.S. Hospitals, 2019*. (https://www.aha.org/statistics/fast-facts-us-hospitals)

- Value of trainees' time to take the training
- Periodic updates to training program content or delivery methods
- Value of trainees' time for refresher training

For each of these cost elements, evaluators must determine if the organization for whom the ROI is being computed bears the cost. Often the most substantial cost of any training program is the value of trainees' time. This value equals wages and benefits times the hours required to complete the training. If an organization is estimating these costs internally, internal accounting systems can provide actual values for wages and benefits.

If an evaluator is estimating these costs with external sources, average hourly wages by occupation and industry are available from the Bureau of Labor Statistics, Occupational Employment Statistics, which are published annually.[2] Similarly, benefits as a percent of wages may be estimated based on *Employer Costs for Employee Compensation*, which are published quarterly by the Bureau of Labor Statistics.[3]

Gains

Estimating the gains associated with a training program is less straightforward than estimating its costs. Estimating gains requires the following steps:

1. Identify the potential gains;
2. Determine how these gains may be estimated or quantified; and
3. For gains that are non-quantifiable, document them to the degree possible.

To identify the potential gains of a program, consider the program's objectives. Viewing potential gains through this lens may naturally identify gains. Conceptually, training is unnecessary if there is no problem to solve. If on point, the training will solve or at least mitigate the problem it is designed to address. On this basis, the gain is the value realized from addressing the problem and should naturally point to how to measure it.

Some gains will be quantifiable and others not. For an ROI evaluation, consider quantifiable gains as those that can be monetized. At a minimum, it is essential that measurable gains offset the costs. Note that given enough assumptions, any gain can be monetized, but some of these assumptions may not be evidence based. For example, there is no obvious way to monetize the value of patient or staff satisfaction.

While some gains are not quantifiable, it is helpful to document them as well as possible because if the measurable ROI is just below or just above the break-even point, decision-makers can consider the non-quantifiable gains to inform their decision about whether to proceed with the training program. How to document the non-quantifiable gains is clearly dependent on the specifics, but likely there is academic literature that will aid in this process.

[2] Occupational Employment Statistics, Bureau of Labor Statistics. (https://www.bls.gov/oes/tables.htm)
[3] *Employer Costs for Employee Compensation*. (https://www.bls.gov/news.release/pdf/ecec.pdf)

Cost of capital

As previously discussed, the ROI is more than a measure of returns compared to the investment. Because the invested funds could have been used in other ways, the ROI is a comparison to the opportunity cost of resources. While cost-of-capital calculations for a specific organization can be complex, the basic concept is to measure how much it costs the organization to raise investment capital.

Most organizations raise funds through a combination of equity and debt. Accordingly, an organization's weighted average cost of capital depends on its specific mix of equity and debt and the costs to raise capital from these sources. The cost of equity is a function of the risk-free return (e.g., return on government bonds), the overall market risk premium over the risk-free return, and the organization's market risk relative to the overall market risk. The cost of debt is a function of the risk-free return, the organization's credit risk, and its income tax rate.
As previously noted, many hospitals and other health care organizations are not-for-profit organizations. As such, estimating their cost of capital is more straightforward because they largely raise capital through debt and are not subject to corporate income taxes. However, to the degree that these organizations have an endowment or investments in equities, they should also consider the expected returns on these investments in their cost-of-capital.

ROI calculation

With time-specific estimates of the training programs costs and gains and the organization's cost of capital, its expected ROI of the training program can be computed. The ROI at year *n* is:

$$ROI_n = \left(\sum_{t=0}^{n} \frac{Gain_t}{(1+r)^t} - \sum_{t=0}^{n} \frac{Cost_t}{(1+r)^t}\right) / \sum_{t=0}^{n} \frac{Cost_t}{(1+r)^t} = \left(\sum_{t=0}^{n} \frac{Gain_t}{(1+r)^t} / \sum_{t=0}^{n} \frac{Cost_t}{(1+r)^t}\right) - 1,$$

where *r* is the cost of capital, *t* is time in years, and ROI_n is a cumulative return after *n* years. It is not an annual rate of return. The annual or per annum ROI after *n* years is computed as follows:

$$per\ annum\ ROI_n = \left(\sum_{t=0}^{n} \frac{Gain_t}{(1+r)^t} / \sum_{t=0}^{n} \frac{Cost_t}{(1+r)^t}\right)^{\frac{1}{n}} - 1.$$

Sensitivity analysis

Unless the training program is well-established or has many similarities to other established training programs, one will not actually know what the gains will be a priori given uncertainty. By design, the training program is intended to solve an existing problem or prevent a future problem, but the effectiveness of doing so is unknown until the training program is implemented and its effectiveness evaluated. Given this uncertainty, a sensitivity analysis can aid decision-makers as they decide whether to make the training investment.

For each of the key assumptions used in estimating the gains, ROI evaluators can vary these assumptions to see how sensitive the finding of a positive ROI is to the changes in each. The literature and/or variation in estimated values for each key assumption may be used as a guide to identifying plausible values both for the initial assumption as well as for alternative values. The sensitivity analysis should focus on showing the consequences to the ROI when results fall

short of expectations. If an organization still finds a positive ROI under more conservative assumptions that provides more confidence that the training program will actually result in a positive return. There is no need to evaluate the sensitivity of the ROI results that exceed expectations. The organization does not want to be surprised by a negative return, so the sensitivity analysis should focus on showing decision-makers how sensitive or dependent the expected ROI is on the assumptions used to estimate the gains.

EPIMN Case Study

This section applies the ROI estimation framework to the Emergency Preparedness Information Modules for Nurses (EPIMN). The Spectrum Health Emergency Preparedness Department surveyed nurses regarding their familiarity with how to respond to emergencies and disasters. They found that 78% of respondents had little to no familiarity. Hence, the objective of this training program is to increase familiarity with emergency and disaster response.

Unit of measurement

The purpose of establishing a unit of measurement is to identify at the organizational level the costs it will incur and benefits it expects to realize from implementing EPIMN. Organizations logically approach investment decisions with an organization-centric view; they are only concerned with costs that they incur and benefits they will realize.

Because EPIMN is designed to help hospitals be better prepared to handle an emergency event, the unit of measurement is a hospital. Note, however, this is not for a specific hospital but a representative or average hospital. Based on data from the American Hospital Association and the Bureau of Labor Statistics, the average hospital has 150 staffed beds and 273.5 RNs.[4] Of these, about 32% of RNs work in critical/intensive care or emergency/trauma care.[5]

Event probability

Because EPIMN helps hospitals be prepared to respond to emergency and disaster events, it is essential to estimate the event probability to put gains in perspective. We have estimated the event probability to include MCIs and infectious disease outbreaks. MCIs would include natural disasters (e.g., earthquakes and wildfires); extreme weather events (e.g., hurricanes); and violence (e.g., terrorism, mass shootings, and non-gun violence with mass casualties). Infectious disease outbreaks would include novel pathogens like Zika and Ebola, for example. Because the number and impact of emergency events varies greatly year to year, we estimated event probability using a 5-year period to minimize the potential bias that would be associated with using the history of a single year that may substantially differ from the long-term average.

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[4] The number of hospitals and staffed hospital beds are from the American Hospital Association, *Fast Facts on U.S. Hospitals, 2019*. (https://www.aha.org/statistics/fast-facts-us-hospitals). The number of RNs employed in general medical and surgical hospitals is from the Bureau of Labor Statistics, Occupational Employment Statistics, May 2018.

[5] U.S. Department of Health and Human Services, Health Resources and Services Administration, *The Registered Nurse Population, Findings from the 2008 National Sample Survey of Registered Nurses*, September 2010, Figures 3-15 & 3-17.

To estimate the probability of an event, we considered FEMA disaster declarations, public health emergency declarations, and data on MCIs from both gun and non-gun violence. Over the 5-year period from 2014 to 2018, there were 567 presidential disaster declarations. However, we assumed that these would have zero to minimal impact on hospitals.[6]

Over the same period, there were 21 public health emergency declarations.[7] These included the California wildfires, Alaskan earthquake, various hurricanes, and Zika. For each of these events, we made assumptions about the percentage of hospitals the event likely affected. For example, Hurricane Irma impacted several U.S. states and territories. We assumed that Hurricane Irma impacted 100% of hospitals in Puerto Rico and the U.S. Virgin Islands but only 5% of hospitals in Florida.[8] Overall, we estimated that 1.75% of hospitals would be affected annually by public health emergencies.

A mass shooting is typically defined as a shooting with 4 or more individuals killed or injured. In a major urban hospital, handling 4 victims may not be unusual but it could be for a community hospital, so there is some gray area on what may qualify as a mass casualty event. For purposes of this analysis, we defined a mass shooting as 10 or more individuals killed or injured. We applied the same definition for non-gun mass casualty events (Table B1).

Table B1. Average annual number of violence events with mass casualties

	Violence mass casualty event definition (killed and injured)			
Type	5 or more	10 or more	15 or more	20 or more
Gun	159.20	9.00	4.40	2.00
Non-gun	1.65	1.03	0.62	0.62
Total	160.85	10.03	5.02	2.62

Note: the data for gun events are based on the 5-year period from June 19, 2014 to June 18, 2019 because the 2019 data were available through this date. The data for non-gun events is for 2014 through November 4, 2018.

To estimate the frequency of these events, we relied on the Gun Violence Archive[9] for gun events and the Johnston Archive[10] for non-gun events. Non-gun events include stabbings and vehicular attacks, for example. To estimate how this would impact hospitals, we assumed that for every 5 individuals killed or injured, 1 hospital would be affected.[11] One this basis, 0.33% of hospitals are affected each year by violent events resulting in mass casualties when defined as

[6] If there is in fact an impact on hospitals, the estimated ROI would be higher than estimated in this case study.
[7] We did not include the 13 renewals of previous declarations.
[8] These are assumptions. Determining which hospitals were specifically affected by each event was outside the scope of this analysis. Hurricane Irma also impacted Georgia and South Carolina. We assumed that 10% of the hospitals in these states were affected.
[9] https://www.gunviolencearchive.org
[10] http://www.johnstonsarchive.net/terrorism/wrjp255a.html
[11] The assumption is that the greater the number of casualties, the higher the probability that more than one hospital will be affected. In an urban area, victims may be distributed across multiple nearby hospitals even if the number of casualties is low. In contrast, such distribution of victims for an event in a rural area may not be possible even if the number of casualties is high.

events with 10 or more victims. If the definition of an MCI is changed to 5, 15, or 20 victims, 2.60%, 0.25%, and 0.18% of hospitals, respectively, are affected annually (Table B2).

Table B2. Average percentage of hospitals impacted by public health and mass casualty events each year

	Violence mass casualty event definition (killed and injured)			
Event type	5 or more	10 or more	15 or more	20 or more
Violence	2.60%	0.33%	0.25%	0.18%
Public health	1.75%	1.75%	1.75%	1.75%
Total	4.35%	2.09%	2.00%	1.93%

Note: totals may not add up due to rounding.

Bringing together the estimates for public health events and violence MCIs, our best estimate is that 2.09% of hospitals (1 in 47.9) are affected annually (Table B2). This estimate is based on including violence MCIs of 10 or more victims. Note if a lower threshold of 5 or more victims is used, the estimate is that 4.35% of hospitals (1 in 23.0) are affected annually. If higher threshold of 15 or 20 victims is used, 1 in 49.9 or in 51.7 hospitals are impacted, respectively. Hence, the percentage of hospitals affected does vary by the definition of a violence MCI, but by choosing a threshold of 10 victims, the high variability of that definition is removed. It is likely that the 2.09% value is an underestimate, given that we did not include all contingencies such as cyberattacks or utility failures.

Costs

Estimating the ROI of EPIMN requires identifying all costs the hospital will incur. This includes any initial investment as well as any future sustainment costs. Costs for any training program include the cost to develop the training, preceptor or IT hosting costs, value of trainees' time, and cost to update the training program.

Training program development costs. Given that the average hospital is the unit of measurement, the hospital-centric ROI is not concerned with the cost of developing the training program as the hospital does not bear this cost. ASPR TRACIE and Spectrum Health developed EPIMN at a cost of $48,000.[12] Even if hospitals were required to share this training cost, the average cost across all hospitals is only $8.

Preceptor or IT hosting costs. ASPR TRACIE and Spectrum Health developed this training as a self-administered online course, which ASPR TRACIE will host. Hence, for the hospital, there are no preceptor or IT hosting costs.

Value of trainees' time. As RNs will take EPIMN as part of their employment, its cost includes the cost of trainees' time. Because this is a case study for a representative hospital, we used average RN wages and benefits to estimate the cost of trainees' time. Data from Occupational

[12] The cost does not include any oversight costs incurred by ASPR TRACIE in the development of EPIMN. Even if we assume such oversight added 25% to costs, the total cost of the training development would be $60,000 or $10 on a per hospital basis.

Employment Statistics show that the average hourly wage of RNs is $36.30 in 2018 dollars. When limited to RNs working in medical and surgical hospitals, the average hourly wage is $37.37.[13] In 2019 dollars, this hourly wage is $38.15.[14] We have used data from the Bureau of Labor Statistics as published in *Employer Costs for Employee Compensation – December 2018*, to estimate employer provided benefits.[15] Based on this source, benefits that are not already accounted for in wages are equal to 27.15% of wages. Hence, the total hourly cost for RNs is $48.51. This case study uses this hourly rate to estimate the cost of EPIMN.

Each of the five modules are worth 0.3 continuing education credits and are estimated to take 30% of an hour to complete. Hence, total training time is 1.5 hours. On this basis, the initial year training costs are $73 per RN. Given that the average hospital has 273.5 RNs, the total initial year costs are $19,906.

Like many investments or initiatives, we expect the costs for this training program will continue beyond the initial year. One reason these costs may continue beyond the initial investment is the natural turnover of workers. Average annual RN turnover over the five-year period from 2014 to 2018 was 16.44% (Table B3). If a hospital is going to continue to have its RNs trained, it will need new hires to take this training as the RN staff naturally turns over. To account for this, we have estimated that annual costs in subsequent years include the training costs for the 16.44% of nurses who would be new to the organization.

Table B3. RN turnover rate, 2014-2018

Year	Turnover rate
2014	16.4%
2015	17.2%
2016	14.6%
2017	16.8%
2018	17.2%
Average	16.44%

Source: Nursing Solutions, Inc. *National Health Care Retention & RN Staffing Report*, various years (2016 to 2019).

Another reason cost may continue beyond the initial year is the natural degradation of knowledge over time. An approach to mitigating this is refresher training. While such refresher training has not yet been developed, this case study included the cost of notional periodic refresher training. Specifically, we assumed 0.75 hours of refresher training every other year for the RN staff that did not turn over.[16] On this basis, the training cost for each subsequent year is

[13] Registered Nurses (29-1141), Occupational Employment Statistics, May 2018, Bureau of Labor Statistics, Registered Nurses (https://www.bls.gov/oes/current/oes291141.htm)
[14] The 2019 value is 2.1% higher than the 2018 value. This is the Congressional Budget Office's projection for the increase in the Consumer Price Index for 2019. (Congressional Budget Office, *The Budget and Economic Outlook: 2019 to 2029*, January 2019, Table E-1.)
[15] Bureau of Labor Statistics, U.S. Department of Labor, *Employer Costs for Employee Compensation – December 2018*, USDL-19-0449, Table 2.
[16] We used 0.75 hours on the assumption that the refresher training would be half the length of the initial training.

$7,058.[17] These estimates assume that all RNs in the hospital receive the training. If, however, training is limited to RNs in critical/intensive care and emergency/trauma care, the training costs for the initial and each subsequent year would be $6,377 and $2,335, respectively (Table B4).

Table B4. Training costs for a representative hospital

	All RNs	Critical/intensive & emergency/trauma care RNs
Initial year		
Hours of training	1.5	1.5
Number of RNs	273.54	87.63
Initial year costs	$19,906	$6,377
Subsequent years		
Initial training		
Number of RNs	44.97	15.97
Cost of initial year	$3,273	$1,162
Refresher training		
Hours of training	0.75	0.75
Number of RNs	104.05	32.24
Cost of refresher training	$3,786	$1,173
Cost per subsequent year	$7,058	$2,335

Notes: The National Health Care Retention & RN Staffing Report (various years) provides RN turnover by specialty. This, combined with the RN specialty distribution from *The Registered Nurse Population*, Findings from the 2008 National Sample Survey of Registered Nurses (Figures 3-15), was used to compute the retention rates. Totals may not add up due to rounding.

Training program update costs. Periodically, a program may need updates to reflect new information or emerging issues. This cost may also include the cost of developing and revising refresher training. In this case study, hospitals do not bear the cost of refresher training program development or updates to training programs. That said, even on a per hospital basis, these costs are assumed to be minimal given the minimal cost of the initial training on a per hospital basis.

Quantifiable Gains

EPIMN is intended to address the pervasive lack of familiarity with emergency and disaster preparedness response. The expectation is that EPIMN will result in both quantifiable and non-quantifiable gains. The distinction is that quantifiable gains can be monetized. This section monetizes quantifiable gains and a subsequent section addresses non-quantifiable gains. The gains we have quantified are the reduced costs associated with RN turnover and the hospital cost inefficiencies associated with RN turnover. Monetizing these gains requires estimating the following:

[17] Note that the cost figure for each subsequent year is the long-run average. We have used the long-run average for simplicity. In the short run, values will vary year to year given the 2-year cycle of refresher training. These annual cycles will smooth out over time given that 16.44% of RNs will turnover each year and be replaced by new hires who will receive the initial training and be on a different cycle for refresher training.

- Impact of training on RN turnover
- The cost of RN turnover
- Hospital cost inefficiencies associated with RN turnover

Impact of training on RN turnover. There is an extensive literature on the determinants of nurse turnover. These determinants include various socio-demographic factors, job satisfaction, nurse workload, stress, local labor markets, work schedule, empowerment, autonomy, organization size, management style, and ownership type (Tai et al. 1998; Hayes et al. 2006; Hayes et al. 2012; Currie and Hill 2012). This analysis, however, is focused on the degree to which EPIMN impacts RN turnover. To proxy that, we considered the degree to which training generally impacts RN turnover.

Mudor and Tooksoon (2011) conducted a review of existing studies and found that training was inversely related to turnover and that the impact is likely to vary by circumstance. Similarly, Casey et al. (2004) found that nurses transitioning from an education program to a clinical practice setting "do not feel skilled, comfortable, and confident for as long as 1 year after being hired, highlighting the need for healthcare organizations to provide extended orientation and support programs to facilitate successful entry into practice" (page 303). Similarly, Lee et al. (2009) found that a preceptor program was associated with 53% lower RN turnover in the first year of employment.[18] While formal education and preceptor programs differ from a training program like EPIMN, the directional impact is applicable.

As this is a prospective analysis, there are no specific estimates for how much RN turnover EPIMN will prevent. As such, an estimate is necessary. Overall RN turnover averaged 16.44% over the 2014-2018 period (Table B5), but turnover varies by nurse specialty. If we assume that the difference in turnover for critical/intensive and emergency/trauma care nurses compared to all other nurses is representative of the turnover that could be avoided by EPIMN should an emergency event occur, we can use this differential to estimate EPIMN's turnover impact. As Table B5 shows, the RN turnover rate for critical/intensive and emergency/trauma care nurses is 18.22% annually compared to 15.60% for all other nurses. This is a difference of 2.62 percentage points or 17% higher for critical care/emergency nurses compared to all others. We have used this 2.62-percentage-point difference to estimate the turnover impact.

How does this 2.62-percentage-point estimate compare with the literature? A study of training and turnover in nursing care facilities found that RN turnover was 9% in non-Alzheimer special care units in facilities with such special care units, compared to 11% in facilities without such units (Grant et al. 1996). This 2-percentage-point retention difference represents 22% higher turnover in facilities without the special care units. The presumption is that the lower RN turnover in the facilities with the special care units is associated with the Alzheimer-specific training these RNs receive.

[18] Marcum and West (2004) and Orsini (2005) also find a link between preceptor-trained new nurses and reduced turnover and that quality of care and patient satisfaction are higher (Lee et al. 2009).

Table B5. RN turnover differential: critical care/emergency compared to all other specialties

	2014	2015	2016	2017	2018	Average
Critical care (CC)/emerg.	18.50%	18.88%	17.53%	17.72%	18.48%	18.22%
Other, not CC/emerg.	15.41%	16.41%	13.22%	16.37%	16.60%	15.60%
Difference	3.09%	2.47%	4.31%	1.35%	1.88%	2.62%
Ratio	1.20	1.15	1.33	1.08	1.11	1.17

Source: Specialty-specific turnover rates are from Nursing Solutions, Inc., *National Health Care Retention & RN Staffing Report*, various years (2016 to 2019). Turnover rates for critical/emergency care nurses and all other specialties were computed using specialty weights from the Health Resources and Services Administration, *The Registered Nurse Population, Findings from the 2008 National Sample Survey of Registered Nurses*, September 2010, Figure 3-15.

For new RNs in a cardiac care setting, Goldschmidt et al. (2011) found the lack of a structured onboarding program was associated with challenges in role assimilation and connectedness with peers. Given these challenges, Kurnat-Thoma et al. (2017) implemented an onboarding performance improvement initiative and found that RN turnover fell to 9.9% from 12.5% before the program. This is 2.6 percentage points or 21% less turnover. Given these examples, the 2.62-percentage-point estimate seems to be a reasonable estimate for this case study.

The cost of RN turnover. Jones (1990) developed the Nursing Turnover Cost Calculation Methodology (NTCCM). This methodology categorized RN turnover costs into direct and indirect costs. Direct costs include the following:

- Advertising and recruiting costs—human resource department costs, supplies, school visits, job fairs, advertising costs, agency and search fees, and recruitment training.
- Vacancy costs or cost of unfilled positions—costs of filling vacancies with temporary workers or through overtime of permanent staff and reduced operations due to staff shortages. These costs are limited to costs in excess of the normal costs of filling these positions on a permanent basis.
- Hiring costs—interview costs and employment processing costs for new employees.

The indirect costs of RN turnover are the following:

- Termination costs—payment of unused vacation and sick time and the costs of processing terminations.
- Orientation and training costs—costs to train new employees on the organization's policies and procedures.
- Cost of decreased productivity of new RNs—costs associated with the lower productivity of RNs during the period it takes them to become 90% as productive as established RNs. This could be described as the cost of the learning curve for new employees.

Jones (2004) updated the NTCCM. The update categorized costs as pre-hire and post-hire costs. Pre-hire costs are the same as direct costs. Post-hire costs are the same as indirect costs with the addition of costs associated with pre-turnover productivity. Pre-turnover productivity costs are those costs associated with reduced productivity of the departing RN as well as reduced productivity of coworkers in the period immediately preceding the RN's departure.

Various studies have used either the NTCCM or updated NTCCM to estimate RN turnover costs. Table B6 summarized the estimates of RN turnover costs from the literature. Due to inflation and changing economic conditions, it is difficult to compare turnover cost estimates from different time periods. To overcome this challenge, the literature expresses RN turnover costs relative to RN salary. The average turnover cost-to-salary ratio across these seven studies was 0.68, but it varied widely from 0.40 to 1.30.[19]

Table B6. RN turnover costs as a percentage of salary

Study	Sample	Turnover cost	RN salary	Turnover cost-to-salary ratio
Waldman et al. (2004)	U.S., 1 medical center	$27,487 (2001$)	$32,000	0.86
Jones (2005)	U.S., 1 hospital	$64,600 (2002$)	$49,840	1.30
O'Brien-Pallas et al. (2006)	Sites across 4 countries	$21,514 (2001$)	$48,240	0.45
O'Brien-Pallas et al. (2008)	Canada, 39 hospitals	$26,652 (2014$)	$66,123	0.40
Lewin Group (2009)	U.S., 13 hospitals	$36,567 (2007$)	$62,480	0.59
North et al. (2013)	N.Z., 11 health boards	$23,711 (2014$)	$47,000	0.50
Roche et al. (2014)	Australia, 11 hospitals	$48,790 (2014$)	$69,740	0.70
Average				0.68

Notes: RN salary for the Waldman et al. (2004) study is as reported by Li and Jones (2013). RN salary for Jones (2005), O'Brien-Pallas et al. (2006), O'Brien-Pallas et al. (2008), Lewin Group (2009), and Roche et al. (2014) are from the Occupational Employment Statistics (various years). The hospitals included in the O'Brien-Pallas et al. (2006) study are in the U.S., Australia, Canada, and New Zealand.

McConnell (1999) indicated that, for hourly positions, the turnover cost-to-salary ratio is about 0.75. This is similar to the 0.68 average across the seven studies in Table B6. Kosel and Olivo (2002) indicated that the turnover cost-to-salary ratio is an increasing function of organizational position: ≤ 0.5 for nursing assistants, ≤ 1.0 for RNs, and ≤ 1.5 for Chief Nursing Officers. Similarly, McConnell (1999) also indicated that the turnover cost-to-salary ratio averages 1.5 for salaried positions. Hence, while there is variation in the literature about the costs of RN turnover, it is reasonable to assume that turnover costs are about two-thirds to three-quarters of annual salary.

These studies show that the largest component of RN turnover costs are the costs associated with filling vacant positions with temporary workers or through overtime of remaining RNs. Jones (2004) defines these costs to include (1) temporary RN costs to fill vacant positions above cost to fill positions with permanent staff, (2) overtime costs of permanent staff to cover vacant positions, (3) lost revenue due to closed bed and patient deferrals, and (4) lost productivity of supervisors and coworkers, among other costs. For the studies in Table B6, the range of costs associated with filling vacancies ranged from 20 to 90% of total turnover costs with an average of 57% across these seven studies.

[19] Jones (1990) and Caudill and Patrick (1991) also estimated the cost of nurse turnover. We have not included these estimates because Jones (2005) is a more recent and complete application of the NTCCM methodology than Jones (1990). We have not included Caudill and Patrick (1991) as its estimates are specific to nursing homes.

Hospital cost inefficiencies associated with RN turnover. Bloom et al. (1997) found that temporary RNs compared to permanent staff significantly increased non-personnel operating cost. Similarly, Alexander et al. (1991) found that RN turnover rate is associated with increased personnel costs and non-personnel operating costs in hospitals.[20] These estimates of increased personnel and non-personnel operating costs overlap to some degree the cost associated with filling vacant positions that the RN turnover cost literature has already accounted for. Specifically, this literature accounts for the cost to fill vacant positions, but these estimates are focused on RN personnel costs. Hence, there is an increase in personnel costs that remains to be accounted for along with the increase in non-personnel costs associated with higher RN turnover.

To estimate these costs, we relied on Alexander et al. (1991), which found that a 1-percentage-point increase in RN turnover was associated with a 0.11% increase in personnel costs and a 0.17% increase in non-personnel costs. Table B7 shows that for a 2.62-percentage-point increase in RN turnover, non-RN personnel costs increased $58,746 and non-personnel costs increased $186,823 for the average hospital.

Table B7. Hospital cost inefficiencies associated with RN turnover

	Current state	With 2.62% more turnover
Average hospital cost per day, 2019$	$2,596	$2,605
Personnel costs (55%)	$1,428	$1,432
Non-personnel costs (45%)	$1,168	$1,173
Average beds per hospital	150	150
Average occupancy rate	65.5%	65.5%
Total personnel costs	$51,179,816	$51,327,494
Non-RN personnel costs (39.8%)	$20,359,407	$20,418,153
Difference		$58,746
Total non-personnel costs	$41,874,395	$42,061,218
Difference		$186,823

Sources: Average hospital costs per day are based on data from the Kaiser Family Foundation for 2017 increased to 2019 dollars using the average annual growth in hospital costs per day over the 2008-2017 period. The portion of personnel costs and non-personnel costs are based on Becker's Hospital CFO Report (2013). The average number of staffed beds per hospital is based on American Hospital Association (2019) data. The average occupancy rate is from *Health, United States* (2017). The percentage of non-RN personnel costs are based on employment and salary figures from the Occupational Employment Statistics (2018) for those working in general medical and surgical hospitals.

Summary of gains. Table B8 summarizes the expected annual gains associated with the emergency preparedness training. These figures are expected values because they are based on the probability that an emergency or disaster event will occur. The average gain for a hospital is $13,275 annually or $4,253 when training is limited to critical/intensive and emergency/trauma care RNs.

[20] See also Alexander et al. (1994).

Table B8. Annual gains from training for a representative hospital

	All RNs	Critical/intensive & emergency/trauma care RNs
Avoided RN turnover costs	$8,143	$2,609
Avoided increase in non-RN personnel costs	$1,228	$393
Avoided increase in non-personnel costs	$3,905	$1,251
Total gains	$13,275	$4,253

Notes: Estimates assume the annual emergency or disaster event probability is 2.09% and that the emergency preparedness training will avoid a 2.62-percentage-point increase in the RN turnover rate. Avoided RN turnover costs are 68% of average RN salary times the event probability times the turnover difference times the number of RNs. Avoided increase in non-RN personnel costs and non-personnel costs are $58,746 and $186,823 (which are associated with the 2.62% turnover difference), respectively, times the event probability. Values for critical/intensive & emergency/trauma care RNs are scales to reflect difference in the number of RNs in these specialties compared to all RNs. Totals may not add up due to rounding.

Cost of capital

The cost of capital is a measure of the cost to raise funds for investment or the opportunity cost of investment. Among non-government community hospitals, 69% are not-for-profit hospitals and 31% are for-profit.[21] Typically, a not-for-profit hospital will raise most of its funds through debt while a for-profit hospital will raise most of its funds through equity. Because not-for-profit hospitals may have an endowment or investments in equities, they also need to consider the cost of equity when computing their cost of capital. For purposes of this case study, we assumed that the weighted average cost of capital is equally weighted between debt and equity. We assumed that the average hospital has a credit risk equal to that of the average market risk. For simplicity and because 69% of non-government hospitals are not-for-profit organizations, we make no adjustment for corporate tax rates.

Over the last 40 years, the average return on debt was 7.39%. This figure is based on corporate Aaa bond yields.[22] Over this same period, the average return on the Standard & Poor's composite index plus dividends was 11.26%.[23] Weighting these equally, the weighted average cost of capital would be 9.32%.

Note that Tables B4 and B8 illustrate costs and gains in 2019 dollars rather than expressing values in 2020 and beyond in nominal dollars. To account for this in the weighted average cost of capital, we have adjusted returns to be net of inflation. The average increase in the Consumer Price Index over the past 40 years was 3.43%.[24] Subtracting this, the inflation-adjusted weighted average cost of capital is 5.89%.

[21] American Hospital Association, *Fast Facts on U.S. Hospitals, 2019*. (https://www.aha.org/statistics/fast-facts-us-hospitals)
[22] Corporate Aaa bond yields are from the *Economic Report of the President*, March 2019, Table B-42.
[23] Standard & Poor's composite index and dividend yields are from the *Economic Report of the President*, March 2019, Table B-56, and the *Economic Report of the President*, January 2001, Table B-95.
[24] Consumer Price Index for all urban consumers, Bureau of Labor Statistics (https://www.bls.gov/data/)

ROI estimate

Given estimated costs, gains, and the average cost of capital, we estimate that the EPIMN will have a positive ROI in the fourth year. By the tenth year, the total ROI is 40.1% or 3.4% on a per annum basis (Table A9). These ROI values assume initial training costs of $19,906, subsequent annual costs of $7,058, and annual gains of $13,275. Hence, after the initial year, the annual net gain is $6,217 (13,275 – 7,058), but given the size of the initial investment, it takes 4 years to recover that investment.

Table B9. ROI by year

			Present value		Cumulative present value			ROI, %	
Year	Costs	Gains	Cost	Gains	Cost	Gains	Net gain	Total	Per year
0	$19,906		$19,906	$0	$19,906	$0	-$19,906		
1	$7,058	$13,275	$6,666	$12,901	$26,572	$12,901	-$13,671	-51.4	-51.4
2	$7,058	$13,275	$6,295	$12,183	$32,867	$25,084	-$7,783	-23.7	-12.6
3	$7,058	$13,275	$5,945	$11,505	$38,812	$36,589	-$2,222	-5.7	-1.9
4	$7,058	$13,275	$5,614	$10,865	$44,426	$47,455	$3,029	6.8	1.7
5	$7,058	$13,275	$5,302	$10,261	$49,728	$57,716	$7,988	16.1	3.0
6	$7,058	$13,275	$5,007	$9,690	$54,735	$67,406	$12,671	23.2	3.5
7	$7,058	$13,275	$4,729	$9,151	$59,463	$76,557	$17,094	28.7	3.7
8	$7,058	$13,275	$4,465	$8,642	$63,929	$85,200	$21,271	33.3	3.7
9	$7,058	$13,275	$4,217	$8,162	$68,146	$93,361	$25,215	37.0	3.6
10	$7,058	$13,275	$3,983	$7,708	$72,129	$101,069	$28,940	40.1	3.4

Notes: Timing of cost and gains matters for present value calculations. Costs are assumed to occur at the end of the year. Gains are assumed to occur mid-year as an emergency event may occur at any time during the year.

Sensitivity analysis

Because EPIMN is new, its cost effectiveness is unknown. The estimated ROI is based on the best available information. But given the uncertainty, we want to see how sensitive the result of a positive ROI is to the key assumptions used to estimate the program gains.[25] These key assumptions are the following:

- Probability of emergency or disaster event
- RN turnover impact of training
- Cost of RN turnover
- Impact of RN turnover on non-RN personnel cost
- Impact of RN turnover on non-personnel cost
- Cost of capital

Table B10 shows the minimum values for these assumptions that will still result in a break-even ROI in the tenth year. The three most critical assumptions are the event probability, the impact on RN turnover, and the cost of RN turnover. The sensitivity analysis shows that the event probability could decrease 28% from our best estimate of 2.09% to 1.50% and still break even after 10 years. The probability of a public health emergency affecting a hospital was 1.75% annually. Hence, even if we assume MCIs associated with gun and non-gun violence had no

[25] We are not concerned with the assumptions used to estimate the costs of the training program as these costs are well-defined and have minimal variability.

impact on hospitals, the public health emergency events alone have a higher probability than the break-even point for event probability for this assumption.

Table B10. Minimum values for key assumptions that result in a positive 10-year ROI

Key assumptions	Best estimate	Minimum value with break-even ROI in 10th year	Per annum ROI in 10th year
Event probability	2.09%	1.50%	0.0%
Training impact on RN turnover	2.62%	1.88%	0.0%
Cost of RN turnover	0.68	0.37	0.0%
Impact of RN turnover on			
Non-RN personnel cost	0.11%	0.00%	2.4%
Non-personnel cost	0.17%	0.01%	0.0%
Cost of capital	5.89%	43.08%	0.0%

Notes: The cost of RN turnover is expressed as the fraction of annual RN salary. The impact of RN turnover on non-RN personnel cost and non-personnel cost is the change in these costs for each percentage-point increase in RN turnover.

The results also show that the impact of the EPIMN on RN turnover could decrease 28% from our best estimate of 2.62% to 1.88% and still break even after 10 years. This assumption has little information available to inform it compared to the other key assumptions. The 2.62% estimate is based on the differences between the RN turnover rates of those in critical/intensive & emergency/trauma care compared to all other RNs. To provide context for this 1.88% break-even point, the low turnover impact for training we cited from the literature was 2 percentage points (Grant et al. 1996).

For the cost of RN turnover, the sensitivity analysis showed that the estimated cost of RN turnover as a fraction of RN salary could decrease 46% from 0.68 to 0.37 and still break even in the tenth year. Estimates from the literature showed that the percent of average RN salary that is accounted for by turnover costs varied widely from 0.40 to 1.30 with a standard error of 0.12. Hence, even the low estimate in the literature is above the break-even point and 2.4 standard errors less than the best estimate of RN turnover.[26]

As for the impact of RN turnover on non-RN personnel costs, the sensitivity analysis showed that this cost can be eliminated and still have a 2.4% per annum return in the tenth year. For the impact on non-personnel costs, the sensitivity analysis showed that it can be reduced from 0.17% to 0.01% and still break even in the tenth year. Finally, the cost of capital can be increased 7.3-fold from 5.89% to 43.08% and still break even in the tenth year.

Non-quantifiable gains

The preceding ROI analysis included only the gains that could be monetized. To the degree that there are non-quantifiable gains, the analysis has underestimated the ROI. The literature shows that these non-qualifiable gains include the impact of RN turnover on quality of care for patients and patient satisfaction as well as benefits for nurses.

[26] Differences of 2.0 standard errors is considered significant at the p = 0.05 level.

For patients, Antwi and Bowblis (2016) found that a 1-percentage-point increase in nurse turnover was associated with a 1.93-percentage-point increase in deficiencies in regulatory surveys and that turnover may increase mortality rates. Similarly, O'Brien-Pallas et al. (2010) found that the nurse turnover rate positively correlated with medical errors. Other studies show that nurse turnover was negatively correlated with patient satisfaction (Leiter et al. 1998) and treatment follow up (Minore et al. 2005).[27]

Dunton et al. (2007) found that higher nurse-to-patient ratios and a greater share of RNs with 10 or more years of experience was associated with lower fall rates. More recently, Cho et al. (2016) found that lower nurse-to-patient ratios were associated with a lower quality of care. Similarly, a meta-analysis found that patient falls was negatively correlated with nurse-to-patient ratios (Stalpers et al. 2015). Aiken et al. (2002) found that lower nurse-to-patient ratios were associated with higher 30-day mortality rate and the failure-to-rescue. While these outcomes are not directly tied to turnover, they are indirectly related and relevant to the degree that nurse turnover exacerbates the challenge of maintaining desirable nurse-to-patient ratios.

As for the impact on nurses, O'Brien-Pallas et al. (2010) found that the nurse turnover rate was negatively correlated with both nurse mental health and job satisfaction. Brewer et al. (2012) found a correlation between nurse turnover and job satisfaction. This matters for patients as nurse job satisfaction was related to fewer adverse events (Boamah et al. 2018). As with quality of care for patients, nurse staffing ratios also affect nurses. Aiken et al. (2002) found that one additional patient per nurse was associated with a 23% higher burnout rate and 15% higher rate of job dissatisfaction for nurses. Tai et al. (1998) note that staffing ratios impact turnover and "a heavy workload may increase job tension and decrease satisfaction, which in turn, may increase the likelihood of turnover" (page 1918).

Summary

Because organizations have limited resources, they must be selective in their investments because resources invested in one project are in turn not available for other projects. ROI estimates facilitate these investment decisions. Still, ROI estimation is challenging for investment decisions in training programs where the gains of the program are not well-defined. Accordingly, the purpose of this report was to (1) detail a framework for ROI estimation in the training context and (2) evaluate the ROI for the Emergency Preparedness Information Modules for Nurses (EPIMN) as an example of how to implement this ROI framework.

Evaluation of the ROI for EPIMN showed a positive ROI by the fourth year. As estimated gains depend crucially on some key assumptions, we evaluated the sensitivity of the ROI estimates for changes in these assumptions. Baseline assumptions were best estimates based on the literature and existing data. The results show that even when substantially more unfavorable values are used for key assumptions, the ROI of EPIMN broke even by the tenth year. Finally,

[27] Turnover is also correlated with the quality of end-of-life care in nursing homes (Tilden et al. 2012).

not all gains of EPIMN, such as quality of care and nurse satisfaction, are quantifiable. Even excluding these gains, EPIMN has a positive ROI by the fourth year.

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