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General Contractor Knowledge of Infection Control Requirements on Hospital Renovation Construction Projects

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Abstract. Healthcare associated infections (HAI) are common afflictions for hospital patients. Construction-related renovation projects are abundant at hospitals in the United States, the results of which have the potential to cause HAI. Hospital-accrediting firms such as the Joint Commission have a strict focus on ensuring that infection control risk management assessments are completed by hospital owners prior to the start of renovation projects. Fifty-six hospital renovation subject matter experts from general contracting firms in the southeastern United States completed a survey to discern their knowledge of and experience with infection control on hospital renovation projects. The survey results showed that (1) general contracting firms place a focus on training their personnel in infection control, as general contractors are most often responsible for ensuring that infection control measures are adhered to, (2) there are an adequate amount of products on the market for infection control, which are utlized on almost every renovation project and (3) field operatives (i.e., the individuals that actually complete the work) should receive more training on infection control. Future research should seek to expand this study into geographic regions outside of the southeastern United States, and to discern how more training of field operatives can be implemented.

Keywords: Healthcare construction, Infection control

1 Introduction

Healthcare-associated infections (HAI) are infections patients contract while receiving medical treatment in a healthcare facility that they did not have prior to arriving at the facility [1]. HAIs are a pervasive issue in hospital settings across the United States, as approximately one in thirty-one hospital patients will acquire a HAI during their stay [1] which equates to over one million people annually [2].

Hospitals operate 24-hours per day, seven-days per week, and are some of the most complex facilities to plan, design, construct, and operate [3]. Hospitals are constantly being renovated and expanded to comply with new standards and technologies, increase operating efficiencies, increase patient market share, and adhere to regulatory

compliance, all which must be completed while the facility stays in operation [4,5]. Moreover, the increasing age of hospital building stock in the United States generates a constant need for repairs and replacements of key pieces of plant and equipment within these facilities. The processes necessary to remediate these depleted items increase the risk of environmental contamination, potentially leading to HAI risks for patients within the facilities [6]. Specifically, contaminants include high concentrations of spores, fungi, and organic matter released from insulation and other finish materials disturbed during the renovation process [7,8].

Healthcare facilities must be inspected and certified to ensure they meet certain requirements of the Centers for Medicare and Medicaid (CMS), the largest funder of healthcare in the United States. National accrediting organizations, such as the Joint Commission, which accredits and certifies nearly 21,000 healthcare organizations and programs, have standards and a survey process that meet or exceed the CMS requirement [9]. It is imperative that these healthcare organizations receive this accreditation. The Joint Commission has a standard purposefully related to HAIs, which states:

"Standard EC.02.06.05 requires the organization to have a pre-construction risk assessment process in place, ready to be applied at any time if planned or unplanned demolition, construction or renovation occurs. Additionally, organizations must have a process that allows for minor work tasks to be performed in established locations or under particular low risk circumstances using predetermined levels of protective practices. The assessment covers potential risks to patients, staff, visitors or assets for air quality, infection control, utility requirements, noise, vibration and any other hazards applicable to the work."

The Joint Commission does not dictate how healthcare organizations assess risk, but instead defers to instructions set forth by the Facilities Guidelines Institute (FGI), which issues guidelines expressly related to healthcare planning, design, and construction. The current version of the FGI Guidelines for Design and Construction of Hospitals requires that owners complete what is called an Infection Control Risk Assessment, or ICRA, as part of their overall safety risk assessment. The ICRA requirement was first published in the 2001-version of the guidelines, which were previously developed by the American Institute of Architects (AIA). A standard template for ICRA assessments has also been developed by the American Society for Healthcare Engineering (ASHE). The ICRA is to be completed by the entire project planning team, including staff from the hospital's infection control department [10]. The results of the ICRA provide designers and contractors with "a written plan that describes specific methods by which transmission of airborne and waterborne biological contaminants will be avoided during construction and commissioning" [11].

2 Research purpose and methodology

The purpose of the research described herein was to discern how informed construction professionals are related to infection control in healthcare construction projects, specifically hospital renovation projects completed by general contractors in the southeastern United States. The research methodology included developing and distributing an online survey instrument of 18 open-ended and closed-ended questions to two large general contractors in the southeastern United States. The survey was targeted towards superintendents, project managers, and corporate executives with substantial experience in healthcare construction (i.e., subject matter experts), especially those with experience in renovation/retrofit projects. Survey questions inquired about the subject matter expert's (SME) experience with hospital renovation, and detailed questions about their knowledge and opinions of infection control. The survey itself was developed using the Qualtrics web-based software platform, and was distributed during July of 2018. Snowball sampling, or requesting that targeted individuals suggest other individuals with similar expertise [12] was used to increase the survey response rate.

3 Survey Results

Fifty-six SMEs completed the survey during July of 2018. Twenty-nine of the SMEs (at the time of the survey) had a superintendent role in their firms, twenty-two had a project management (PM) role, and five had an executive role. (Note: all of the data presented herein has been sorted based on SME roles.) All of the SMEs had completed at least one hospital renovation/retrofit project within the preceding five years.

3.1 Infection control familiarity and training

The SMEs were asked three questions in the survey regarding (1) how did they first become familiar with infection control, (2) had they ever received formal training regarding infection control measures, and (3) what topics were included in the training, such as types of infections, risk analysis, strategies for infection control during construction, and infection control documentation methods. The results to the first question concerning how the SME's first became acquainted with infection control is shown below in Table 1. As shown, none of the SMEs stated that they were not familiar with infection control. Forty-five of the fifty-six SMEs, or 87.5 percent, first became acquainted through their company's training program.

Table 1. Survey responses to the question "How did you hear about infection control during construction for the first time?"

	Super	PM	Exec	All
Work contract term/project specifications	4	2	0	6
Hospital facility manager/staff	1	1	0	2

Your company's training program	23	18	4	45
Healthcare facility's training program	1	1	1	3
I have not heard about it	0	0	0	0

Fifty-three of the fifty-six SMEs, or nearly 95 percent, stated that they had previously received some kind of formal training concerning infection control. The topics covered in the infection control training are summarized below in Table 2. As shown, strategies for infection control during construction was the most prevalent topic covered in the training sessions, followed closely by documentation and checklists, risk analysis as per the work area and construction activity, and types of infections. Additionally, 55 of the 56 SMEs, or 98 percent, were familiar specifically with ICRA.

Table 2. Topics covered in infection control training sessions completed by SMEs

	Super	PM	Exec	All
Type of infections	20	16	3	39
Risk analysis as per the work area and construction activity	24	17	4	45
Strategies for infection control during construction	28	19	4	51
Documentation and checklists	26	19	4	49

3.2 Infection control importance, responsibility, strategies, and cost

The SMEs were asked six questions related to their firm's perceived importance of infection control, who carries the responsibility of infection control on hospital renovation projects, and infection control and prevention strategies.

Fifty-four of the fifty-six SMEs, or 96 percent, stated that infection control (on their last major renovation project) was deemed to be "extremely important" by their firm. The two other SMEs stated that infection control was very important. The SMEs also stated that, by and large, the general contractor carried the responsibility of ensuring that infection control measures were implemented correctly, as shown in Table 4. The healthcare facility manager, individual subcontractors, and special consultants simultaneously carried this responsibility on some projects, but at a lower overall scale.

Table 4. Survey responses to the question "On your most recent major healthcare renovation in the last five years, who was most often responsible to ensure infection control measures were implemented correctly?

	Super	PM	Exec	All
General Contractor	28	21	5	54
Healthcare Facility Manager	7	9	0	16

Individual subcontractor	2	3	0	5
Dedicated individual or Special Consultant	5	3	0	8

The SMEs were asked if specifications for infection control measures were included in the contract documents on their last major hospital retrofit project. Forty of the fifty-six SMEs, or 71.4 percent, stated that yes, specifications were provided. Furthermore, the SMEs were asked what infection prevention strategies were put into place on their last major hospital retrofit project (based on a provided list), the results of which are shown below in Table 5. Maintaining negative air pressure in the area under renovation was overall shown to be the most prevalent strategy implemented, with 100 percent of SMEs stating that this strategy was implemented. Sealing the work area with plastic sheets and tape, using portable air purifiers, and isolating the HVAC system were also very highly implemented strategies, with 54 of the 56 SMEs, or 96 percent, stating that these measures were utilized.

Table 5. Infection control measures implemented by SMEs on their last major hospital retrofit project

	Super	PM	Exec	All
Maintaining negative pressure in area under renovation	29	22	5	56
Sealing the work area with plastic sheets and tape	29	21	4	54
Portable air purifiers	28	21	5	54
Isolating HVAC system	28	21	5	54
HEPA filter Cart	25	19	5	49
ICRA sealing products	23	19	5	47
STARC partitions	11	7	2	20
None of the above	0	0	0	0

The SMEs were asked to rank (using a Likert scale) a list of four potential problems related to the implementation of infection control measures on hospital renovations: lack of training for construction professionals, lack of effective management systems of protocol, communication and coordination between different entities (e.g., subcontractors, facility management), and the unavailability of ready-to-use products/systems for infection control. The average rankings are provided below in Table 6, where a ranking of "1" equated to the "biggest problem", and the ranking of "4" equated to the "smallest problem." The SMEs overall felt that a lack of training for construction professionals was the biggest problem related to the implementation of infection control measures, while the availability of products and systems for infection control was the smallest problem.

158 **Table 6.** SME ranking of potential problems related to implementation of infection control
159 measures

	Super	PM	Exec	All
Lack of training for construction professionals	1.59	1.86	1.6	1.68
Lack of effective management systems or protocol	2.48	2.68	2.2	2.45
Communication and coordination between different stakeholders	2.41	1.95	2.4	2.26
Unavailability of ready to use products/systems for IC	3.52	3.5	3.8	3.61

160 Lastly, the SMEs were asked about the percentage of overall project cost spent on
161 infection control measures on their last major hospital retrofit project. The results
162 provided in Table 7 show that one to two percent of overall project cost was the most
163 prevalent response.

164 **Table 7.** Percentage of overall project cost spent on infection control measures on last major
165 hospital retrofit project completed by SMEs

	Super	PM	Exec	All
< 1%	5	8	2	15
1% - 2%	11	10	2	23
2% - 3%	7	1	1	9
> 3%	6	3	0	9

166 # 4 Discussion of results

167 The survey results show that infection prevention is paramount in hospital renovation
168 projects, no matter what the size, and that the general contractors who undertake these
169 projects are most frequently responsible for ensuring that infection control measures
170 are implemented. Construction firms that work in this arena focus on training their
171 senior personnel about infection control, with HAI-causing risk identification and
172 mitigation strategies being emphasized. Hospital renovation SMEs feel that there are
173 sufficient products and systems available for infection prevention, and tactics such as
174 negative air containments (including associated temporary barriers and air filtration
175 systems) are almost always utilized.
176 One surprising survey result was that SMEs feel that a lack of training for
177 construction personnel is (relatively speaking) the biggest problem related to the
178 implementation of infection control measures. The authors feel this relates to the actual
179 field operatives that complete the work on these projects, as opposed to the management
180 staff that oversees the work. Field operatives may receive only limited training on

infection control, and may not fully understand the consequences of their actions related to how their specific work actions may cause HAI issues. Furthermore, field operatives working for subcontractors may only spend a short time on a project, as little as a day, and may not receive any project-specific training. This may occur even though the contract documents between the subcontracting firm and the general contractor may stipulate a requirement for such training, and include heavy damages if infection control practices are not adhered to.

Finally, the sheer cost of infection control on hospital renovation projects is substantial, with most SMEs stating that costs were in the 1-2 percent range. On a 50,000 square foot renovation project, assuming a cost of $200 per square foot, the cost for infection control alone could be $200,000. This pure overhead cost is entirely substantiated, though, considering the negative effects that not instituting sufficient infection control may have on the population of patients in a facility being renovated. This sentiment is what drives accrediting agencies such as the Joint Commission to place such a large focus on ICRA-type risk assessments by owners ahead of the start of any renovation project.

5 Conclusions, limitations, and future research

HAIs are an unfortunate side effect that many Americans experience associated with a hospital stay. Renovation work within hospitals can lead to HAIs, but general contractors that complete these projects and the firms that supply this industry have focused on mitigating HAI-causing contaminants through training of key personnel, risk assessment, and implementation strategies. Hospital renovation SMEs do feel, though, that more training of construction operatives is needed moving forward.

The results presented were limited to superintendents, project managers, and executives of southeastern United States general contractors, hence these results may not be generalizable to construction professionals or projects outside of this scope. Furthermore, the exact number of individual firms represented in this sample is not exactly known, as snowball sampling was utilized. Future research should seek to expand the sample to construction professionals in other regions of the United States, and the world. Moreover, further research should be performed to discern how construction operatives can better be trained and prepared for the infection-related demands of completing hospital renovation projects.

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