Skin and Soft Tissue Infections: Using a Severity Stratification Tool to Improve Knowledge

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Abstract

Skin and soft tissue infections (SSTI's) are a significant health concern with serious potential implications. Evidence suggests the importance of implementing a severity stratification tool to improve early identification of SSTI's. The aim of this evidence based project is to examine if educating healthcare staff on the use of a severity stratification tool would increase staff knowledge of SSTI's. The sample consisted of 18 participants, 12 healthcare providers and 6 healthcare staff at a correctional facility in the Southwestern United States. A pre-and posttest design, including an educational session was implemented. A 14-item multiple choice self-developed questionnaire was used to evaluate participants' knowledge of identifying and ranking SSTI's using the CREST tool. A one tail paired *t*-test was performed to compare the pre-and post-test case study scores for the healthcare provider group. A significant increase from pre-test to post-test case study scores was found ($t(13)= -6.19$, $p < 0.00$). Of the healthcare providers, 57% found the tool "moderately helpful." Of the non-provider sample, 50% found the tool "extremely helpful" and plan to use the tool "all of the time." The findings of this study suggest that implementing an educational session on a wound severity stratification tool improves staff knowledge and increases the likelihood of the tool being used in practice. Recommendations for future research include larger sample sizes across a variety of regional correctional facilities to further explore the use and knowledge of the tool in practice.

Keywords: skin and soft tissue infections, severity stratification tool, CREST tool

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The incidence of primary care visits for skin and soft tissue infections (SSTI's) have substantially increased over recent years. This is of greater significance in high-risk patient populations, such as immune compromised patients and inmates. Not only have SSTI's increased, but also the emergence of Methicillin Resistant Staphylococcus Aureus (MRSA) has further complicated this issue. SSTI's have had severe economic and health status consequences that impact healthcare resources, patient safety and quality of care.

Problem Statement

Skin and soft tissue infections (SSTI's) have presented problems for primary care patients in recent years. SSTI's account for nearly 14 million primary care visits each year in the United States (U.S.), and this statistic has been climbing in the last decade (Ramakrishan, Salinas & Higuita, 2015; Ray, Suaya & Baxter, 2013). Skin and soft tissue infections originate from a bacterial invasion of the skin, resulting in a variety of skin presentations (Ramakrishan, Salinas & Higuita, 2015; Lee et al., 2016). These particular presentations can be classified as either simple (involving superficial tissue) or complicated (involving deep tissues) SSTI's. Common simple SSTI's include cellulitis, impetigo, folliculitis, furuncles, carbuncles and abscesses. Complicated SSTI's include necrotizing fasciitis, gangrene and infections of animal or human bites (Ramakrishan, Salinas & Higuita, 2015; Ray, Suaya & Baxter, 2013).

The emergence of *Methicillin Resistant Staphylococcus Aureus* (MRSA) has further complicated the incidence of skin and soft tissue infections. MRSA is a gram-positive cocci bacterium that presents as a break in the skin, abscess or boil that has become resistant to standard antimicrobial treatment (Lee et al., 2016). In the United States, approximately 80-90% of SSTI's are found to contain the bacterium MRSA (Lee et al., 2016; Mullen & O'Keefe, 2015).

SSTI's affect all populations, but an increased incidence has been seen in high-risk patients, which includes correctional facility inmates (Mullen & O'Keefe, 2015). The rise of MRSA in correctional facilities in the U.S. over the last decade has caused great concern not only for inmates and correctional staff, but when individuals are released from prison back into society (Mullen & O'Keefe, 2015). The number of incarcerated individuals in the United States has increased by 300% since 1980, increasing the risk of acquiring MRSA in correctional facilities, but also in the community upon release (Mullen & O'Keefe, 2015).

Purpose and Rationale

Skin and soft tissue infections are a significant health concern with serious potential implications that can affect health status of communities and impact the healthcare system through increased emergency room visits and hospitalizations related to complicated SSTI's (Lee et al., 2016; Ramakrishan, Salinas & Higuita, 2015; Ray, Suaya & Baxter, 2013). If an SSTI goes untreated or treatment is delayed due to difficult diagnostic accuracy the condition may progress to sepsis, deformity, skin grafts, necrotizing fasciitis, limb amputation or even death (Lee et al., 2016; Ramakrishan, Salinas & Higuita, 2015; Ray, Suaya & Baxter, 2013). In 2005, nearly 11,406 people died of MRSA infections in the U.S. (Mullen & O'Keefe, 2015). This is more than the number of people in the U.S. that died of Acquired Immune Deficiency Syndrome (AIDS) in that same year (Mullen & O'Keefe, 2015).

SSTI's also pose a significant financial burden. The annual cost of community acquired MRSA is 478 million to 2.2 billion U.S. dollars (Lee et al., 2013). This impacts the U.S. department of corrections (DOC) as 15 to 36 million U.S. dollars are spent annually in the American jail system on costs related to MRSA alone (Lee et al., 2013). By exploring the root

cause of the increased incidence of SSTI's, one can explore potential interventions to decrease the occurrence and severity of SSTI's in the community and correctional setting.

Background/Significance

An emergence of SSTI's, specifically MRSA, has been seen in distinct patient populations that include: athletic teams, students in dormitories, military recruits, the homeless population and the incarcerated (Malcolm, 2011). Overall though, the correctional facility inmate population is at an even higher risk of MRSA then other population groups. Many of the potential risk factors for SSTI's and MRSA often directly correlate with this subgroups personal demographics and residential setting (Malcolm, 2011; Mullen & O'Keefe, 2015). Factors such as overcrowded living conditions, outdoor work assignments, self-draining of abscesses, sharing soap, washing clothes by hand and close contact with persons known to have MRSA contribute to the incidence and prevalence of this condition. Additional co-morbid health related issues include obesity, diabetes mellitus and inadequate hygiene (Malcolm, 2011; Mullen & O'Keefe, 2015; Ray, Suaya & Baxter, 2013). In a three-year study of predictors of SSTI's, authors Ray, Suaya and Baxter (2013) determined that of the 376,262 patients studied with SSTI's, 50% had a diagnosis of diabetes mellitus.

Additionally, inmates generally have a higher incidence of past intravenous (IV) drug use, alcohol abuse, prison tattoos, Human Immunodeficiency Virus (HIV), Hepatitis B, Hepatitis C and tuberculosis, which are also high-risk factors for MRSA (Mullen & O'Keefe, 2015; Ramakrishnan, Salinas & Higuita, 2015). Recent research demonstrates a correlation between age, MRSA risk factors, and SSTI (Malcolm, 2011; Ramakrishnan, Salinas & Higuita, 2015). In a study of correctional inmates, authors found that inmates ages 30-49 years were significantly more likely to have MRSA infections than patients less than 29 or patients over the age of 50

(Malcolm, 2011). There is no known cause for this increase in the prevalence of MRSA in ages 30 to 49 years of age (Malcolm, 2011; Ramakrishnan, Salinas & Higuita, 2015).

Despite preventative efforts, the incidence of SSTI's continues to escalate, and treatment failure is widespread (Lee et al., 2016; Miller et al., 2015; Suaya et al., 2014). Potential barriers to restrain this trend include a lack of standardized polices, screening and education. Research demonstrates that a primary barrier is a lack of standardized policies or tools for early diagnosis and treatment of SSTI's (Flanagan, 2014; Marwick, 2011; Mullen & O'Keefe, 2015; Talan et al., 2014). Wound management is often an area of expert opinion versus evidence-based practice, making it difficult to formulate policies and standardized tools (Flanagan, 2014). The signs and symptoms of SSTI's can be masked or vague, making proper diagnosis difficult (Tiwari & Lal, 2014). SSTI's also can be difficult to diagnose related to their considerable variability and severity (Hashem, Hidayat, Berkowitz, & Venugopalan, 2016; Tiwari & Lal, 2014). In 2005, the Infectious Disease Society of America (IDSA) developed guidelines for MRSA infection treatment (Stevens et al, 2014). These guidelines were then updated by IDSA in 2014, but still no other guidelines have been produced for SSTI's in general and the actual implementation of these guidelines in primary care is lacking (Stevens et al., 2014).

Inadequate education, screening and standardized policies have been noted in correctional facilities across the U.S. (Malcolm, 2011; Mullen & O'Keefe, 2015). In a study of a correctional facility in Omaha, Nebraska researchers discovered the facility to be deficient in a specific treatment policy and guideline for MRSA SSTI's (Mullen & O'Keefe, 2015). The authors created and implemented a screening and treatment policy for 132 inmates with MRSA SSTI (Mullen & O'Keefe, 2015). As a result, by improving the screening and treatment procedure for SSTI's they were able to improve staff education, patient education and patient

outcomes (Mullen & O'Keefe, 2015). In another correctional facility in Georgia, after a MRSA outbreak staff implemented a multi-modal intervention and noted similar results (Malcolm, 2011). In this study the authors incorporated interventions to include screening for skin lesions, personalized hygiene, antimicrobial therapy, and standardized wound care (Malcolm, 2011). As a result, the MRSA rate of infection decreased from 11.6 per 10,000 inmates to 0 per 10,000 inmates in the post-study period (Malcolm, 2011).

The management of SSTI's is primarily related to infection severity, location and patient co-morbidities (Ramakrishnan, Salinas & Higuita, 2015; Stevens et al., 2014; Tiwari & Lal, 2014). Despite this being common practice for management and treatment, there is no standardized severity scale for SSTI's (Tiwari & Lal, 2014). Several studies have tested established severity tools for accuracy and reliability. The CREST tool measures severity of illness with SSTI's (Hashem et al., 2016; Marwick, 2011). The CREST tool is based on the Eron classifications (Marwick, 2011). In this study, the authors used the CREST hierarchical scoring system to measure SSTI severity ranging from one to four, with one being least severe SSTI and four being most severe SSTI (Hashem et al., 2016). Through the CREST scoring system, researchers were able to accurately ascertain SSTI severity and determine proper antimicrobial treatment (Hashem et al., 2016). Researcher Marwick (2011) also created his own tool based on the Eron classification and CREST tool. This tool also used a severity scale of one to four, one being least severe SSTI and four being most severe SSTI (Marwick, 2011). The researcher looked at appropriate empirical antibiotic treatment of SSTI's based on the SSTI severity classification (Marwick, 2011). Marwick (2011) discovered there to be a lack of consistency in antimicrobial treatment strategies. Over 43 different antimicrobials were selected in the treatment of SSTI's in this study (Marwick, 2011). In another study, the authors looked at using a severity

stratification algorithm in formulating treatment strategies for SSTI's (Tiwari & Lal, 2014). The authors created this algorithm and it has not yet been tested in any other studies. The algorithm addressed whether the patient has redness, warmth, pain or swelling to wound, signs of sepsis, and size of wound. The authors found this algorithm helpful with proper detection of severity and subsequent treatment for SSTI's (Tiwari & Lal, 2014).

SSTI's and MRSA also present a significant financial burden to patients, third party payers, and health care facilities (Lee et al., 2013; Suaya et al., 2014). In a study of inpatients and outpatients with SSTI's in the United States, the mean annual cost for treatment for a single SSTI case was $8,865 (Suaya et al., 2014). The pharmacological treatment and medical/nursing care for MRSA is complicated compared to a SSTI caused by another bacterium. This is reflected in the mean cost for treatment for a single case of MRSA-SSTI being estimated at $40,046 U.S. dollars (Suaya et al., 2014). The financial burden of SSTI's have also been recognized in U.S. correctional systems. In a study of the financial implications of MRSA and SSTI's, the researchers studied a U.S. correctional facility in Pittsburg (Lee et al., 2013). At Cook County correctional facility, the authors determined the annual societal cost of SSTI's to be $140,275 U.S. dollars, reflecting not only cost to patients and third-party payers but also to society (Lee et al., 2013).

As a whole, the literature identifies risk factors for skin and soft tissue infections that substantiate the high incidence for SSTI's in the correctional system. These risk factors include: overcrowded populations, poor hygiene, IV drug use, alcohol abuse, HIV, Hepatitis B and C, age and co-morbid conditions such as diabetes. The literature also identifies barriers to decreasing the incidence of SSTI's, principally the lack of a standardized tool or policy for SSTI identification, management and treatment. Thus far, studies have shown that implementing a

standardized policy, algorithm or severity rating scale have improved patient outcomes and decreased the rate of SSTI's and MRSA.

Internal Evidence

In a county correctional facility in the Southwestern U.S., the incidence and prevalence of SSTI's in this population has been of concern, especially related to MRSA SSTI early identification and treatment. Because of the high incidence of MRSA SSTI's, the organization's healthcare providers no longer culture wounds, but instead presume MRSA and treat skin and soft tissue infections accordingly. This correctional facility has no standardized policy or algorithm for how nursing staff or medical providers should treat SSTI's. This inquiry has led to the clinically relevant PICOT question: In adults at high risk for skin and soft tissue infections how does a risk stratification severity tool compare to usual wound diagnosis, affect time to healing and hospitalization rates?

Search Strategy

In order to address how a wound severity stratification tool can improve patient outcomes an exhaustive search of the literature was undertaken. Databases searched for the literature review included PubMed, Elton B Stephens Company host (EBSCO host) and Web of science. Keywords searched included: "soft tissue skin infection," "MRSA," "correctional facilities," "community acquired" "primary care" and "management." The following limits were placed: Adult population, English language and date limits 2012 to 2017. Date limits were expanded to 1980 to capture landmark studies. Over 5,000 studies were initially yielded, so then Boolean phrases and MESH terms were utilized. Inclusion criteria for the studies included adult population and diagnosis of SSTI. Exclusion criteria included studies prior to 2012 (except landmark studies) and patients younger than 18 years of age. The MESH terms search method

for PubMed yielded 2,402 results (Appendix A). Using MESH term “skin and soft tissue infections” and title/abstract keyword “primary care”, the search was further narrowed and four of the articles yielded were pertinent to this project. The search was then narrowed to MESH term “skin and soft tissue infections” and title/abstract keyword “correctional facilities,” which yielded five articles. Using hand search, other references to other articles were found. These studies contained “MRSA” in their title. So a search was done for MESH term “MRSA” and title/abstract keyword “correctional facilities” yielding three results pertinent to the topic of interest.

The Boolean phrase term search for SSTI on EBSO host yielded 4,628 studies (Appendix B). By using connected Boolean phrases results yielded were narrowed down to 727 when combined terms of “MRSA” and “community acquired” were used. At this time, the search was still yielding a large quantity of unrelated studies. Boolean phrases were then used for “MRSA” and “management”, which resulted in 288 studies. Then “MRSA” and “correctional facility” was searched which resulted in 14 studies. Two selected studies were repeated in above search of PubMed, but the search also yielded one new study pertinent to topic. This study was a landmark study and outside of 5-year date inclusion criteria. Web of science search for key word “soft tissue skin infection” yielded 731 results (Appendix C). These results were then narrowed adding “management” to current search, which resulted in 54 studies. Of these 54 studies three met inclusion criteria for this topic. Roughly 20 articles were initially reviewed for inclusion, but 10 were ruled out due to poor documentation, inconclusive evidence, weak descriptive or statistical data, misleading conclusions or impertinent data or results. The ten studies that were chosen for inclusion met the criteria and were relevant to the stated PICO question. Each study was

reviewed and the data was extracted and organized in an evidence table for examination (Appendix D).

Evidence Synthesis

Ten studies have been chosen for inclusion in this literature review. All studies were evaluated using rapid critical appraisal and were placed in evaluation and synthesis tables (Appendix D, Appendix E). Overall, the strength of the studies were moderate, encompassing six level II evidence and four with level III evidence, in which three were retrospective cohort studies, one observational cross-sectional study, and five prospective cohort studies (Appendix D). The stated PICOT question was better answered by retrospective and prospective studies, resulting in lower levels of evidence. However the ten included studies were substantiated by statistically significant results (Appendix D). None of the studies stated theoretical frameworks or models, but they were implied. A large majority of these implied models, focused on prevention models to include: Levels of prevention model and Millio's prevention framework. All articles required a diagnosis of SSTI's. Very few of the studies listed specificities or sensitivities for their measuring instruments, but the majority of the studies used some form of a risk stratification severity ranking system adopted for SSTI's (Appendix D). This is suspected due to no formally accepted severity scale of SSTI's yet. Reliability and validity of these tools was identified in six of the articles, showing statistical significance in using risk scales to reduce poor patient outcomes (Appendix E). Possible bias was noted in three of the studies, all three of which were funded by Pharmaceutical companies, but when researching these companies further none of the antimicrobial treatment options utilized in these studies appeared to be their products (Appendix D). Seven of the studies took place in hospital settings and the remaining three studies took place in community settings. The selection of hospital settings appears to be related to

current research focusing on causation and risk factors of SSTI's in hospital admissions. Additionally, five of the studies took place in Europe and five took place in the U.S. Since the CREST tool was created in Scotland, it is more highly utilized in Europe currently. Homogeneity was present in demographic data. A large proportion of the studies saw an association between increased age and comorbidities, resulting in poor patient outcomes. Patient outcomes were measured across the studies as increased time to healing, death, re-occurrence of SSTI or re-hospitalization (Appendix E). Several studies incorporated the CREST scoring or the authors own adaptation of it. Overall the studies found the variables lesion size, fever and duration of skin infection to be the most significant in determining the severity of the infection when using the tool (Appendix D). Heterogeneity of the studies was noted especially in the selection of a severity stratification tool. The studies used a variety of severity stratification tools. Some of the studies used established scoring tools to include CREST, SEWS and Ki/Rothstein, while others developed modified severity scoring tools or risk stratifications (Appendix E). Across the studies though, all of the tools were shown to be statistically significant in improving utilization of appropriate antimicrobial treatment measures and to improve patient outcomes.

Current practice in the identification and management of SSTI's is inconsistent with evidence based practice guidelines. Evidence suggests the importance of implementing a severity stratification tool to improve early identification of SSTI's, which in turn can improve long-term patient outcomes. The research does not show evidence of one severity tool being highly accurate over another, but the research collectively shows any severity tool utilized in SSTI identification and treatment, results in improved patient outcomes. Although, the CREST tool was the most frequently used tool and had more robust research compared to the other severity stratification tools. A severity stratification tool is a quick, easy and low-cost item to prevent

hospitalizations, surgical interventions and mortality related to SSTI's. The proposed evidence based project includes educating healthcare providers and nurses, in a Southwestern correctional facility on the use of the CREST tool in an effort to increase staff knowledge of proper identification and treatment of SSTI's, and for healthcare staff to have an increased rate of use of this tool in their practice.

Conceptual Framework and EPB Model

Implementation of an SSTI severity stratification tool focuses on early detection to prevent worsening of SSTI disease state. *The Models of Prevention theory* suits this project design (Nilsen, 2015). This model emphasizes the idea that health is on a continuum, with health at one end and advanced disease on the other. The model uses three levels of application of preventative measures that can be used to promote health and stop the disease at different points along the continuum. This continuum has four levels: primordial, primary, secondary and tertiary (Nilsen, 2015). Secondary and tertiary levels would be appropriate for the severity stratification tool for SSTI's, given the SSTI is already established and the goal is early identification and treatment, to prevent increased severity of disease.

The evidence based model (EBP) *Advancing Research and Clinical Practice through Close Collaboration* (ARCC) facilitated the proposed practice change. This model resembles an organizational plan for a department (Appendix F). The model first focuses on assessing the organizational culture and the readiness for system wide implementation, then on identifying organizational barriers and strengths to EBP implementation plan and follow through with actually implementing the EBP intervention (Schaffer, M.A., Sandau, K.E. & Diedrick, L., 2012). This is an appropriate model for a large organization. The organization where the project was implemented is resistant to change. Using ARCC one could first evaluate specific barriers

staff may have with implementation of this project. One of the nurse practitioners at this facility was used as an EBP mentor. Throughout this project, the EBP mentor was utilized in this capacity, which is consistent with this model.

Project Methods

Evidence based project approval was obtained through Arizona State University Investigation Review Board (IRB) and through facility medical director approval. Participants were recruited using flyers, email invitations and word of mouth. Inclusion criteria required the participants to be 18 years or older, the ability to read and write the English language and a current employee of the identified correctional facility. A consent letter was provided to the participants prior to the intervention that included information on the project participation risks and benefits. The potential benefits of this project included: potential increase in knowledge related to skin and soft tissue infections and a potential increase in self-confidence to assess, diagnose and treat skin and soft tissue infections. The only potential risk for participants identified was time away from other work duties in order to complete the educational session, which could potentially increase work burden. Participants were also aware that they could with draw from the project at any time, as it was stated in the consent letter. Additionally, by participants completing the educational session it was considered implied consent to participate in the project. In order to protect the project participants' identity, participants selected a unique number of their choosing and were instructed to write this number on the top of their pre-test and post-test. These unique identifiers functioned to maintain the participants' privacy, while still allowing for pre-and post-test data to be compared.

The project setting is an outpatient clinic in a correctional facility in the Southwestern U.S. that houses over 2,440 inmates. This facility also houses a 60-bed medical infirmary and a

primary care clinic. The outpatient clinic includes over 75 nurses and over 20 healthcare providers. This is a site with several barriers to change. Because of inmates being a high-risk population, changes to policies and procedures have to go through a stringent and laborious process before being implemented in this setting. Also, initially staff and key stakeholders were not open to the idea of change. To these staff members, a practice change was viewed as a burden to practice. Because of the many hurdles involved with invoking change at this site, resistance to change was expected and occurred initially.

The final sample size consisted of 18 participants, 12 healthcare providers in the provider group and 6 healthcare staff members in the non-provider healthcare group. The intervention itself included a pre-and posttest design and an educational session. The interventional sessions took place at two separate events in October 2017, one for the healthcare providers at their monthly provider meeting and one for the nurses and other healthcare members at their monthly educational meeting. At these two meetings, participants were initially provided with the consent letter. After reading over the consent letter, participants were given a self-created pre-and post-test and a severity stratification tool algorithm. The pre-and post-test questionnaires were reviewed by faculty for content and validity. The algorithm itself is a self-created tool that incorporates the CREST tool into a helpful and easy to use algorithm for healthcare members to use for easy identification, assessment and treatment of SSTI's. This algorithm was determined to be a reliable and accurate tool after review by several experts for accuracy. The participants were directed to put a unique identifier number at the top of the pre-and post-test and to then place the post-test to the side. Prior to the educational session, participants were given fifteen minutes to complete the pre-test of knowledge. And after the educational session was complete, participants were given fifteen minutes to complete the posttest of knowledge. Both the pre-test

and post-test involved questions related to identifying SSTI's and case study questions. The questions were the same on the pre-and post-test, except for three questions on the post-test involving if the participant felt the tool was helpful and whether they would use it in practice. Additionally, the demographic questions were only on the pre-test, not on the post-test. The questions for the provider group versus the non-provider group slightly differed. The non-provider group case study questions only included questions to identify and assess SSTI's using the CREST tool, whereas the health care provider case study questions included diagnosing and treating SSTI's using the CREST tool. Immediately following the pre-test, a thirty-minute educational session was presented to the participants by the project leader using power point slides. This power point presentation included information on the background and significance of the issue, information on the CREST tool for assessing, diagnosing and treating SSTI's. Participants were also supplied with a copy of the CREST tool algorithm and time was allotted for questions or clarifications. Immediately following the educational session, a fifteen-minute post-test was administered.

Since there is currently no instrument specifically focused on improvements in knowledge of SSTI's, a self-developed questionnaire was used. The developed questionnaire is a 14-item scale, with multiple choice questions. Unanswered questions were treated as incorrect answers, and were recorded accordingly. This scale was developed to measure healthcare staff's knowledge of severity rankings of SSTI's using specifically the CREST tool. The measurement includes questions on descriptions of SSTI's, proper ranking of SSTI's, participants' comfort level with managing patients with SSTI's and whether participants plan to use the CREST tool in practice. Reliability and validity on this instrument was determined by multiple revisions and improvements through feedback from several research and data experts.

At the conclusion of the intervention, all pre-and post-test sheets were collected and were double checked to ensure the pre-and posttest for each participant had their unique identifying number at the top of the tests. These completed pre-and post-tests were then scanned to a password protected computer with no participant identifiers on them. Data was manually entered into the statistical software SPSS. Questionnaires were broken down into several categories based on the multiple-choice questions. Gender, education, license, age was recorded based on a Likert scale. The questions on wound characteristics for non-providers and providers were broken down into a pre-and post-test category. One point was awarded for each correct question for these sections, and these questions were totaled to offer a score. Similarly, for pre-and post-test case study scores for non-providers versus providers, one point was awarded for each correct question and these questions were totaled to offer a score. A Likert scale was used for three questions related to usefulness of the tool in practice and actual implementation of the tool in practice. This was completed and rechecked by the project lead several times for correct data entry and accuracy. It was then further verified for accuracy by the co-investigator and the statistical consultant. Descriptive statistics and inferential statistics were completed to include a one pair tailed t- test comparing pre-and post-test case study scores for healthcare provider group and the non-healthcare provider group.

Outcomes/Project Results

Descriptive statistics were used to describe the sample and outcome variables. The age of the subjects ranged from 25 to 74 years. The sample (n= 18) consisted of 12 (67%) females and 6 (33%) males. The majority (89%) of the sample had an educational degree of a Master's degree or higher. The sample size was made up of 12 healthcare providers and 6 individuals that were not providers. The healthcare provider sample (n= 12) was made up of 2 (11%) nurse

practitioners, 6 (33%) physician assistants and 4 (22%) physicians. There was no statistical significance in the descriptive statistics except for a significant increase in healthcare provider pre-test to post-test case study scores. A one tail paired *t*-test was performed to compare the pre- and post-test case study scores. The mean of the pre-test case study scores was 3.57 (*SD*= 1.60), and the mean of the post-test case study scores was 6.21 (*SD*= 1.97). A significant increase from pre-test to post-test case study scores was found ($t(13)= -6.19$, $p < 0.00$). Of the healthcare providers, over half (57%) found the tool "moderately helpful" and 61% of them plan to incorporate the tool in practice at least "some of the time." The non-provider sample (n=6) was made up of 1 Licensed Practical Nurse, 1 Clinical Nurse Specialist and 4 unknown. The non-provider sample was too small to run any inferential statistics. Of the non-providers, half (50%) found the tool "extremely helpful" and plan to use the tool "all of the time." The data suggests a statistical significance in improvements in post test case study scores for healthcare providers, showing an increase in knowledge from pre-intervention to post intervention. The data also suggests that the majority of healthcare providers and nurses planned to use the tool in practice, 75% of the non-providers and 85% of the healthcare providers reported that they plan to use this tool in practice.

Discussion

Through this study it was determined that by educating and implementing a severity stratification tool, staff knowledge improves and staff have a plan for an increased use of the tool in practice. At the provider and nurse level the impact of the project was seen through the data that reflects improvements of case study scores and willingness to use the tool in practice. This translated to the participants actually planning to implement the CREST tool into their own practice. At a system level, after completion of the project, administration is considering making

the CREST tool educational PowerPoint and algorithm accessible and mandatory to all providers. Since changing policy in this public-sector organization is difficult, no plans are in place at this time to make the CREST tool algorithm and its use a part of policy, but may at least be making the education portion mandatory. Having the education portion mandatory for providers could be a stepping stone to making the algorithm available as a procedural tool as well. The project intervention is planned to be sustained by a second-year Doctor of Nursing Practice student. This student plans to continue the project with her focus on implementing the CREST tool and algorithm facility wide. Through implementing this tool facility wide in practice, she plans to look at specific patient outcomes and financial spending. This is expected to be implemented by next fall. The financial implications of this study were very minimal. The only cost was minimal and was covered by the project leader as costs for snacks at the educational session. As for longevity of this project the only cost would be paying employees to undergo the training session, which could easily be completed in 30 minutes to an hour. Implementing education on a severity stratification tool is a low cost and efficient intervention to improve staff knowledge of SSTI's.

This study had several limitations. By sharing in these experiences hopefully these limitations will be avoided as the project is sustained and carried forward. One of the limitations of this study is the small sample size (n= 18) and non-provider sample size (6). Only inferential statistics could be conducted on the provider sample, not on the non-provider sample group, since the non-provider sample was too small to run any inferential statistics. With a larger sample size, inferential statistics in the non-provider group could be included. This leaves much room for additional studies with larger sample sizes to further explore the use of the tool and knowledge of the tool in practice. Another limitation to the study was that the participants were

asked their job title as a multiple-choice question. Several participants left this section blank. It was discovered later that several x-ray technicians and physical therapists attended the provider meeting. This finding could have potentially skewed the data results. The strengths of the study were the larger sample size of the healthcare providers, which allowed for inferential statistics to be completed, determining that the health care provider group had a statistically significant increase in knowledge from pre-intervention to post intervention. Another strength of the study was the attrition rate, no participants exited the study early and all participants who completed a pretest also completed a post test, improving the consistency of the data that was obtained.

Conclusion

Through this evidence based project it was determined that by implementing an educational session on a severity stratification tool for SSTI's, healthcare providers had an improvement in knowledge related to diagnosing and treating SSTI's using the CREST tool. Not only was staff knowledge improved, but the majority of participants found this tool to be helpful and had plans to incorporate it into their daily practice. Hopefully now this project can be moved one step further to determine if it is actually being used by healthcare staff in the field. By arming healthcare staff with the knowledge of the CREST tool, there is an opportunity to diagnoses and treat SSTI's early on to promote improved communication amongst health care staff, improved assessment coordination and ultimately improved patient outcomes for this high risk and vulnerable population.

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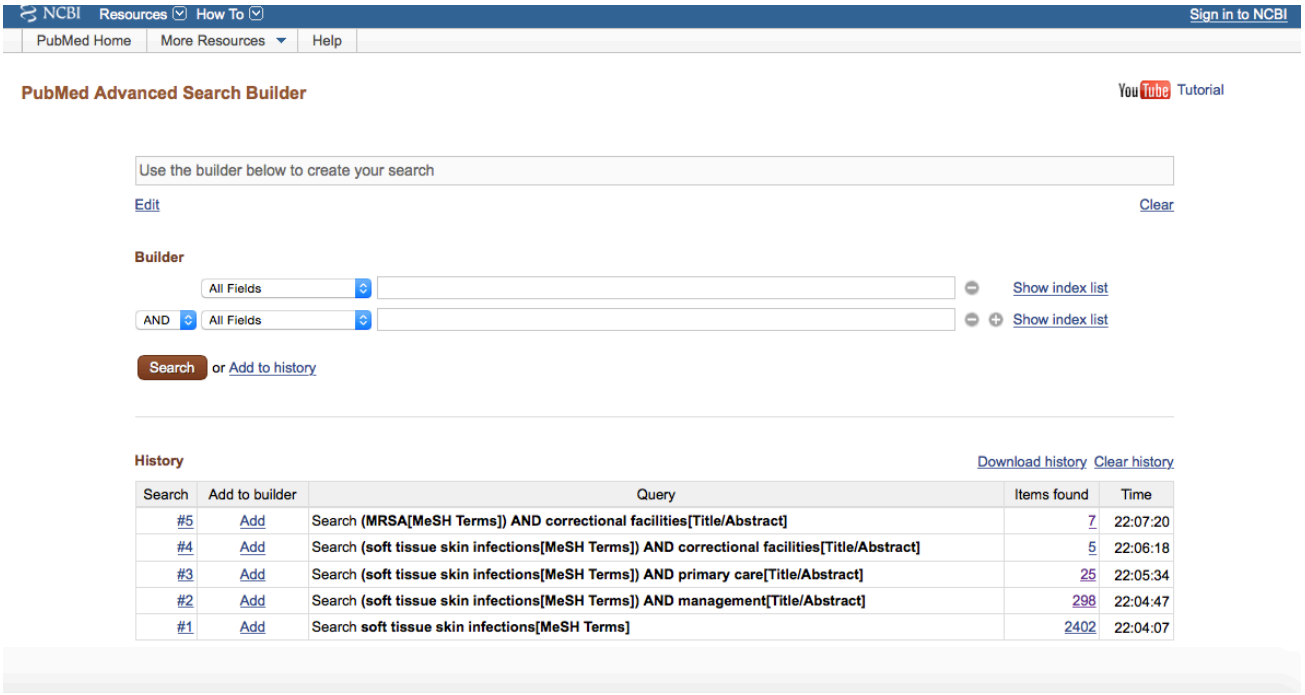
Appendix A

Search Strategy 1

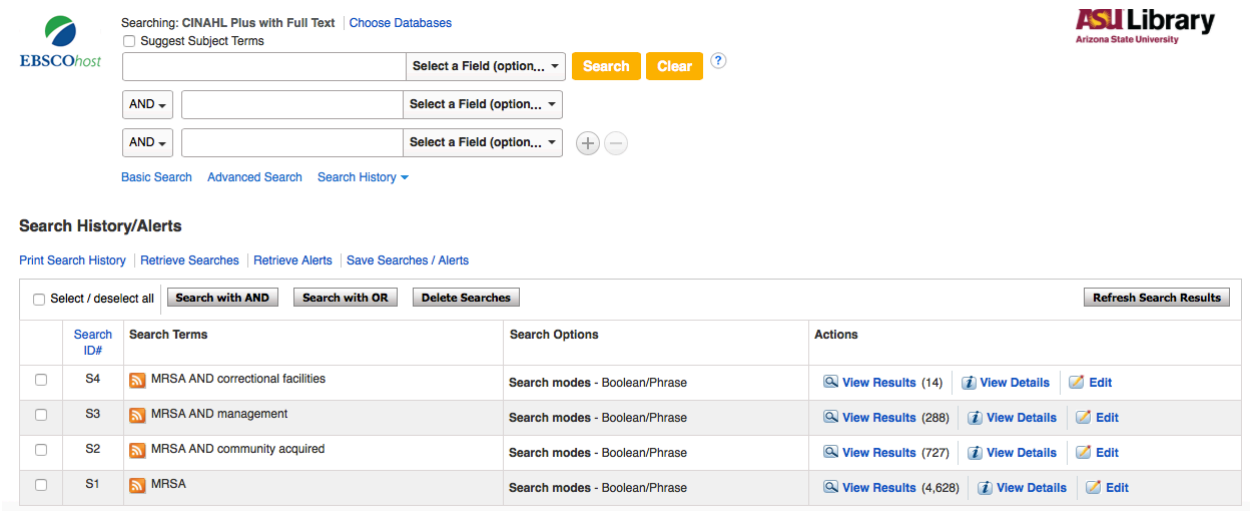
PubMed



Appendix B

Search Strategy 2

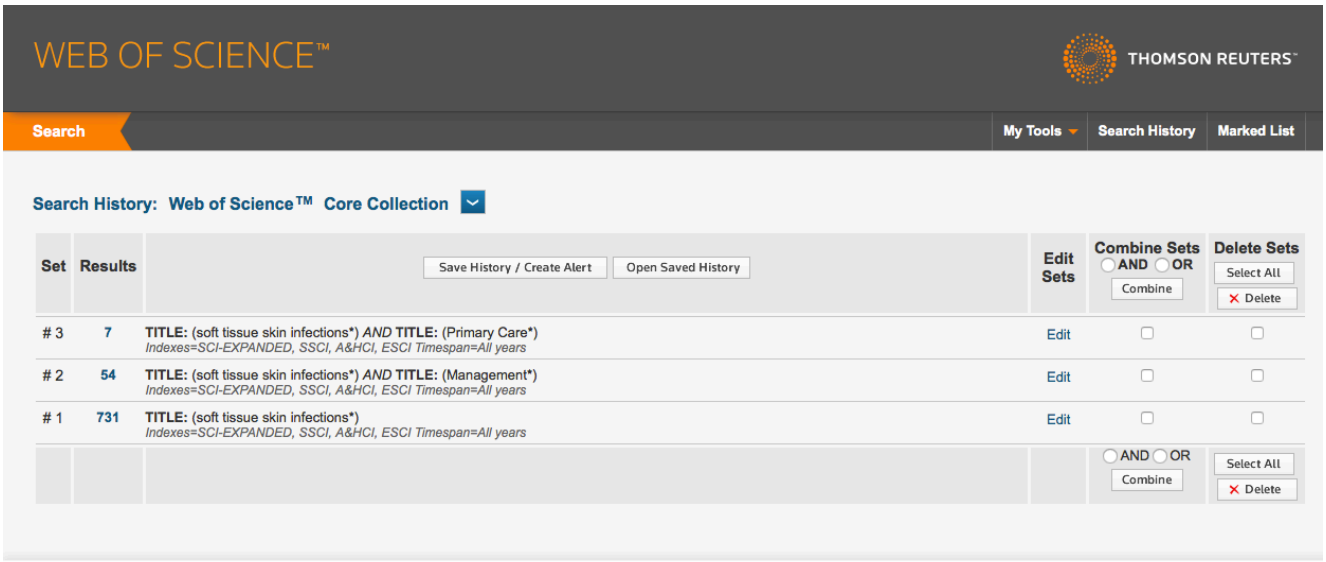
EBSO host



Appendix C

Search Strategy 3

Web of Science



WEB OF SCIENCE™ THOMSON REUTERS

Search | My Tools | Search History | Marked List

Search History: Web of Science™ Core Collection

Set	Results	Save History / Create Alert / Open Saved History	Edit Sets	Combine Sets (AND / OR) Combine	Delete Sets Select All / Delete
# 3	7	**TITLE:** (soft tissue skin infections*) *AND* **TITLE:** (Primary Care*) *Indexes=SCI-EXPANDED, SSCI, A&HCI, ESCI Timespan=All years*	Edit	☐	☐
# 2	54	**TITLE:** (soft tissue skin infections*) *AND* **TITLE:** (Management*) *Indexes=SCI-EXPANDED, SSCI, A&HCI, ESCI Timespan=All years*	Edit	☐	☐
# 1	731	**TITLE:** (soft tissue skin infections*) *Indexes=SCI-EXPANDED, SSCI, A&HCI, ESCI Timespan=All years*	Edit	☐	☐
				AND / OR Combine	Select All / Delete

Appendix D

Evaluation Table

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Figtree, M. (2012). Risk stratification and outcome of cellulitis admitted to hospital. Funding: None Conflict/Bias: None Country: Sydney	Millio's framework for prevention	Design: Retrospective cohort study Purpose: To identify risk factors associated with mortality and adverse outcomes of community acquired cellulitis requiring hospital admission	N= 395 n= 1 SS= 1 650 bed Tertiary referral hospital in Sydney, Australia M age= 70.6 F= 57% IC= Hospitalization between January 1999 and December 2006, diagnosis code for cellulitis	IV1- Age>60 IV2- Impaired mobility IV3- > Co-morbidities IV4- Albumin <30 IV5= symptoms > 4 days IV6= Antibiotics delayed >8 hours DV1=Hospital stay >7days	Predictive risk tool model created by authors	Pearson's chi square, Fischer's exact test, One way analysis of variance, univariate analysis, logistic regression, 2 tailed tests of significance P= <0.05	IV1- P= <0.001* Iv2- P= <0.001* IV3= P= 0.004* IV4= P=<0.001* IV5= P<0.001* IV6= P< 0.001* DV1=36.1% Findings: Pt	LOE: Level III W: Study design, selection bias, associations detected are not necessarily causations but associations, residual confounding may have occurred, study pertains to cellulitis SSTI's only. S: Stringent inclusion and exclusion criteria, practical

A: age, **AA:** African American, **ABSSI:** Acute bacterial skin and skin structure infections, **ADL:** activities of daily living, **AGR:** age range, **AHRQ:** Agency for research healthcare and quality, **APP:** application, **BSA:** Body surface area, **C:** Caucasian, **CA:** cellulitis/abscess, **CA-MRSA:** Community acquired Methicillin resistant staphylococcus aureus, **CCR:** Clinical cure rate, **CF:** correctional facility/facilities, **CI:** Confidence interval, **CM:** Co-morbidity, **CR:** Complete response, **CR%:** Caucasian race percentage, **DAT:** days of antibiotic therapy, **DIA:** Delayed Initiation antibiotics, **DS:** Duration of symptoms, **DT:** Duration of therapy, **DV:** dependent variable, **E:** ethnicity**, EC:** exclusion criteria, **ED:** emergency department, **ESM:** Economic Simulation Model, **F:** female, **FE:** Feasibility, **G:** gender, **H:** Hispanic, **HCUP:** healthcare cost and utilization project, **HOW:** history of wound, **IC:** inclusion criteria, **I&D:** incision and drainage, **IPT:** Inpatient treatment, **IV:** independent variable, **KPNC:** Kaiser Permanente of Northern California, **LHS:** Length of hospital stay, **LOA:** lack of adherence, **LOE:** Level of evidence, **M:** male, **MA:** Metanalysis, **M Age:** Mean age, **MIDAS:** Models of Infectious Disease Agent Study, **MOR:** Mortality, **n:** sample size studies, **ME:** Median, **N:** sample size cases/people, **MRSA:** Methicillin resistant staphylococcus aureus, **NF:** necrotizing fasciitis, **NI:** Not identified in article, **NIS:** nationwide inpatient sample,, **NWC:** Negative wound culture, **O:** Obese, **OP:** outpatient, **OPT:** Outpatient treatment, **OT:** Over treatment, **PC:** participant characteristics, **PWC:** Positive wound culture, **PRTM:** Predictive risk tool model, **PCS:** Prospective cohort study, **RCS:** Retrospective cohort study, **REH:** Re-hospitalization, **RR:** Reference range, **RSST:** Risk severity stratification tool, **SA:** staphylococcus areus, **SABSSSI:** Severity of acute bacterial skin and skin structure infections, **SI:** site of infection, **SEWS:** Standardized early warning score, **SIRS:** systemic inflammatory response syndrome, **SR:** Systematic Review, **SS:** Number of study sites, **SS:** Severity of SSTI, **S/S:** Signs/symptoms, **SSTI's:** Skin and soft tissue infections, **STP:** standardized treatment plan, **TF:** treatment failure, **TS:** type of SSTI, **UK:** United Kingdom, **USA**: United States of America, **UT:** Under treatment, **VS:** Vital signs abnormalities, **WBC:** white blood cell count, **WS:** Wound size, **Y:** years, **$:** US dollars, **$$:** US dollars in Millions,

			EC= Myositis, necrotizing fasciitis, diabetic foot infections, <16 years of age				with admission risk factor <4 at a low risk of adverse outcomes, Risk increased with score. Multivariate factors independently associated with hospital stay > 7days included age >60, symptom duration> 4days, Bacteremia.	clinical endpoints, largest study of in-hospital mortality APP: Appropriate risk stratification can prioritize patients for timely antibiotic administration. This study can help provider to know using risk stratification whether patient needs to be admitted or can remain in community.
Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice

A: age, **AA:** African American, **ABSSI:** Acute bacterial skin and skin structure infections, **ADL:** activities of daily living, **AGR:** age range, **AHRQ:** Agency for research healthcare and quality, **APP:** application, **BSA:** Body surface area, **C:** Caucasian, **CA:** cellulitis/abscess, **CA-MRSA:** Community acquired Methicillin resistant staphylococcus aureus, **CCR:** Clinical cure rate, **CF:** correctional facility/facilities, **CI:** Confidence interval, **CM:** Co-morbidity, **CR:** Complete response, **CR%:** Caucasian race percentage, **DAT:** days of antibiotic therapy, **DIA:** Delayed Initiation antibiotics, **DS:** Duration of symptoms, **DT:** Duration of therapy, **DV:** dependent variable, **E:** ethnicity**, EC:** exclusion criteria, **ED:** emergency department, **ESM:** Economic Simulation Model, **F:** female, **FE:** Feasibility, **G:** gender, **H:** Hispanic, **HCUP:** healthcare cost and utilization project, **HOW:** history of wound, **IC:** inclusion criteria, **I&D:** incision and drainage, **IPT:** Inpatient treatment, **IV:** independent variable, **KPNC:** Kaiser Permanente of Northern California, **LHS:** Length of hospital stay, **LOA:** lack of adherence, **LOE:** Level of evidence, **M:** male, **MA:** Metanalysis, **M Age:** Mean age, **MIDAS:** Models of Infectious Disease Agent Study, **MOR:** Mortality, **n:** sample size studies, **ME:** Median, **N:** sample size cases/people, **MRSA:** Methicillin resistant staphylococcus aureus, **NF:** necrotizing fasciitis, **NI:** Not identified in article, **NIS:** nationwide inpatient sample,, **NWC:** Negative wound culture, **O:** Obese, **OP:** outpatient, **OPT:** Outpatient treatment, **OT:** Over treatment, **PC:** participant characteristics, **PWC:** Positive wound culture, **PRTM:** Predictive risk tool model, **PCS:** Prospective cohort study, **RCS:** Retrospective cohort study, **REH:** Re-hospitalization, **RR:** Reference range, **RSST:** Risk severity stratification tool, **SA:** staphylococcus areus, **SABSSSI:** Severity of acute bacterial skin and skin structure infections, **SI:** site of infection, **SEWS:** Standardized early warning score, **SIRS:** systemic inflammatory response syndrome, **SR:** Systematic Review, **SS:** Number of study sites, **SS:** Severity of SSTI, **S/S:** Signs/symptoms, **SSTI's:** Skin and soft tissue infections, **STP:** standardized treatment plan, **TF:** treatment failure, **TS:** type of SSTI, **UK:** United Kingdom, **USA**: United States of America, **UT:** Under treatment, **VS:** Vital signs abnormalities, **WBC:** white blood cell count, **WS:** Wound size, **Y:** years, **$:** US dollars, **$$:** US dollars in Millions,

Hashem, N.G. (2016). Management of skin and soft tissue infections at a community teaching hospital using a severity of illness tool. Funding: None Conflict/Bias: None Country: USA	Levels of prevention model	Design: Retrospective Cohort study Purpose: To retrospectively apply CREST to a Cohort of hospitalized patients with SSTI's and to assess the relationship between disease severity and appropriateness of antimicrobial management.	N= 200 n= 1 SS= one 416 bed community teaching hospital in Brooklyn, NY M age= 54 M= 53% IC= Primary discharge diagnosis SSTI, admitted from January to December 2011, >18 years of age, EC= Admitted with cellulitis associated with DM, <18 years of age.	IV1- Severity of SSTI IV2- Early recognition of SSTI DV1- Over-treatment DV2-Under-treatment DV3- Complete Final response DV4- Clinical Stability	IV1- CREST scoring IV2- SEWS Scoring (Class I least severe-class 4 most severe) DV1, DV2,- Measured based on antimicrobial route and spectrum of activity based on suspected pathogens in each severity class. DV3, DV4-	ANOVA, Fischer's Exact test P<0.05	IV1- Statistically significant IV2- Statistically significant DV1- Overtreatment most common in least severe classes P= <0.05* DV2- 50% class 4 undertreated DV3- 83% of classes 1 through 3 achieved complete response. DV4- Median time 3 days in classes 1 - 3	LOE: Level III W: study design, patient classifications were not assessed by an independent viewer; CREST is not applicable to MRSA patients. S: Easy application of CREST tool to clinical practice, can use in hospital setting or outpatient setting, low cost APP: By using severity scoring for SSTI's providers can ensure adequate treatment for SSTI.

A: age, **AA:** African American, **ABSSI:** Acute bacterial skin and skin structure infections, **ADL:** activities of daily living, **AGR:** age range, **AHRQ:** Agency for research healthcare and quality, **APP:** application, **BSA:** Body surface area, **C:** Caucasian, **CA:** cellulitis/abscess, **CA-MRSA:** Community acquired Methicillin resistant staphylococcus aureus, **CCR:** Clinical cure rate, **CF:** correctional facility/facilities, **CI:** Confidence interval, **CM:** Co-morbidity, **CR:** Complete response, **CR%:** Caucasian race percentage, **DAT:** days of antibiotic therapy, **DIA:** Delayed Initiation antibiotics, **DS:** Duration of symptoms, **DT:** Duration of therapy, **DV:** dependent variable, **E:** ethnicity, **EC:** exclusion criteria, **ED:** emergency department, **ESM:** Economic Simulation Model, **F:** female, **FE:** Feasibility, **G:** gender, **H:** Hispanic, **HCUP:** healthcare cost and utilization project, **HOW:** history of wound, **IC:** inclusion criteria, **I&D:** incision and drainage, **IPT:** Inpatient treatment, **IV:** independent variable, **KPNC:** Kaiser Permanente of Northern California, **LHS:** Length of hospital stay, **LOA:** lack of adherence, **LOE:** Level of evidence, **M:** male, **MA:** Metanalysis, **M Age:** Mean age, **MIDAS:** Models of Infectious Disease Agent Study, **MOR:** Mortality, **n:** sample size studies, **ME:** Median, **N:** sample size cases/people, **MRSA:** Methicillin resistant staphylococcus aureus, **NF:** necrotizing fasciitis, **NI:** Not identified in article, **NIS:** nationwide inpatient sample,, **NWC:** Negative wound culture, **O:** Obese, **OP:** outpatient, **OPT:** Outpatient treatment, **OT:** Over treatment, **PC:** participant characteristics, **PWC:** Positive wound culture, **PRTM:** Predictive risk tool model, **PCS:** Prospective cohort study, **RCS:** Retrospective cohort study, **REH:** Re-hospitalization, **RR:** Reference range, **RSST:** Risk severity stratification tool, **SA:** staphylococcus areus, **SABSSSI:** Severity of acute bacterial skin and skin structure infections, **SI:** site of infection, **SEWS:** Standardized early warning score, **SIRS:** systemic inflammatory response syndrome, **SR:** Systematic Review, **SS:** Number of study sites, **SS:** Severity of SSTI, **S/S:** Signs/symptoms, **SSTI's:** Skin and soft tissue infections, **STP:** standardized treatment plan, **TF:** treatment failure, **TS:** type of SSTI, **UK:** United Kingdom, **USA**: United States of America, **UT:** Under treatment, **VS:** Vital signs abnormalities, **WBC:** white blood cell count, **WS:** Wound size, **Y:** years, **$:** US dollars, **$$:** US dollars in Millions,

					measured as number of days			
Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Jenkins, T.C. (2011). Decreased antibiotic utilization after implementation of a guideline for inpatient cellulitis and cutaneous abscess. Funding: Department of patient safety and quality, Denver Health	Millio's framework for prevention, Levels of prevention model	Design: Retrospective Pre-intervention and post-intervention study Purpose: To explore whether implementing an institutional guideline to standardize and streamline the evaluation and treatment of inpatient cellulitis	N= 344 n= CO n= 169 I n= 175 Median age: CO=46 I=47 M: CO= 75% I= 66% SS= Denver health integrated system (includes	IV= Without standardized treatment plan IV2=With standardized treatment plan DV1= Duration of therapy DV2= Days antibiotic therapy administered DV3= Clinical failure (Treatment failure,	SAS Data analysis DV1= Number of calendar days Pt received treatment DV2= Sum of calendar days of each antibiotic administered	Pearson X, Fischer exact, Wilcoxon rank sum P<0.5	IV= Statistically significant IV2=Statistically Significant DV1= Decreased by 3 days in I group P<0.001* DV2= P=Decreased in I group P<0.001*	LOE: Level III W: Reviewer bias due to study design, Subject to period effect, study preformed at a single institution, preformed on only a subset of patients with SSTI's S: Intervention is broadly applicable, uses

A: age, **AA:** African American, **ABSSI:** Acute bacterial skin and skin structure infections, **ADL:** activities of daily living, **AGR:** age range, **AHRQ:** Agency for research healthcare and quality, **APP:** application, **BSA:** Body surface area, **C:** Caucasian, **CA:** cellulitis/abscess, **CA-MRSA:** Community acquired Methicillin resistant staphylococcus aureus, **CCR:** Clinical cure rate, **CF:** correctional facility/facilities, **CI:** Confidence interval, **CM:** Co-morbidity, **CR:** Complete response, **CR%:** Caucasian race percentage, **DAT:** days of antibiotic therapy, **DIA:** Delayed Initiation antibiotics, **DS:** Duration of symptoms, **DT:** Duration of therapy, **DV:** dependent variable, **E:** ethnicity**, EC:** exclusion criteria, **ED:** emergency department, **ESM:** Economic Simulation Model, **F:** female, **FE:** Feasibility, **G:** gender, **H:** Hispanic, **HCUP:** healthcare cost and utilization project, **HOW:** history of wound, **IC:** inclusion criteria, **I&D:** incision and drainage, **IPT:** Inpatient treatment, **IV:** independent variable, **KPNC:** Kaiser Permanente of Northern California, **LHS:** Length of hospital stay, **LOA:** lack of adherence, **LOE:** Level of evidence, **M:** male, **MA:** Metanalysis, **M Age:** Mean age, **MIDAS:** Models of Infectious Disease Agent Study, **MOR:** Mortality, **n:** sample size studies, **ME:** Median, **N:** sample size cases/people, **MRSA:** Methicillin resistant staphylococcus aureus, **NF:** necrotizing fasciitis, **NI:** Not identified in article, **NIS:** nationwide inpatient sample,, **NWC:** Negative wound culture, **O:** Obese, **OP:** outpatient, **OPT:** Outpatient treatment, **OT:** Over treatment, **PC:** participant characteristics, **PWC:** Positive wound culture, **PRTM:** Predictive risk tool model, **PCS:** Prospective cohort study, **RCS:** Retrospective cohort study, **REH:** Re-hospitalization, **RR:** Reference range, **RSST:** Risk severity stratification tool, **SA:** staphylococcus areus, **SABSSSI:** Severity of acute bacterial skin and skin structure infections, **SI:** site of infection, **SEWS:** Standardized early warning score, **SIRS:** systemic inflammatory response syndrome, **SR:** Systematic Review, **SS:** Number of study sites, **SS:** Severity of SSTI, **S/S:** Signs/symptoms, **SSTI's:** Skin and soft tissue infections, **STP:** standardized treatment plan, **TF:** treatment failure, **TS:** type of SSTI, **UK:** United Kingdom, **USA**: United States of America, **UT:** Under treatment, **VS:** Vital signs abnormalities, **WBC:** white blood cell count, **WS:** Wound size, **Y:** years, **$:** US dollars, **$$:** US dollars in Millions,

medical center Conflict/Bias: None Country: USA		and abscess would decrease antibiotic and health care resource utilization.	hospital, ED, urgent care, sub-specialties, primary care, public health) IC= Principal discharge diagnosis of cellulitis or cutaneous abscess from January 1st 2007 to December 31st 2007 or July 9th 2009 to July 8th 2010, >19 years of age EC= <19 years of age, transferred from another hospital, leaving against medical advice, chronic ulcer, peripheral arterial disease, animal/human bite, necrotizing fasciitis, or hospital	recurrence of re-hospitalization) DV4= Use of serum ESR, CRP DV5= Microbiological cultures DV6= Imaging DV7= Length of hospital stay	DV3= Number of patients with treatment failure, reoccurrence re-hospitalization in a 30 day period DV4= Number of ESR, CRP use DV5= Number patient cases that used cultures DV6= number of cases imaging was used		DV3= CO- 7.7% I- 7.4% P=0.93 DV4= P= 0.006* DV5= Decreased with I group P=0.003* DV6= Decreased with I group P= 0.2* DV7= P=0.43	only a minimal amount of financial resources APP: Implementation of a clinical practice guideline for cellulitis and cutaneous abscesses results in shorter durations of more targeted antibiotic therapy, with a decrease in use of healthcare resources without negatively effecting pt. outcomes.

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			admission, Nursing home or surgery within last 90 days. Stay in ICU		DV7= Sum of calendar days of hospital stay			
Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Lane, S. (2016). Identification of patient characteristics influencing setting of care decisions for patients with acute bacterial skin and skin structure infections: Results of a discrete choice experiment. Funding: The	Multifactorial Causation Theory	Design: Observational Cross-sectional study Purpose: To understand the patient attributes that affect clinical decision-making regarding the setting of care for ABSSSI treatment. Method: 3 part Online Survey	N= 400 M age= USA- 45 UK- 42 M= USA- 64.5% UK- 70% SS=USA, United Kingdom providers (50 emergency room specialists, 50 infectious disease specialists, 50	IV1- Severity of ABSSSI IV2- Comorbidities IV3- Age IV4- Lack of adherence DV1= Decision to treat as inpatient or outpatient	IV1- Mild, moderate, severe depending on presence of fever, abnormal VS, SIRS criteria, Sepsis or organ failure IV2- classified as minor or major	Multinomial Model CI: 95% Mixed effects Model	IV1- Severe ABSSSI resulted in decreased percentage of outpatient treatment CI 0.02 – 0.07 Mild ABSSSI resulted in increased probability of outpatient treatment CI 0.94 to 0.99	LOE: Level II W: Convenience sample and may not represent general population, nature of sample could have introduced selection bias, differing definitions of mild, moderate and severe ABSSSI's exists which could

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Medicines Company Conflicts/Bias: The author is an employee of the Medicines Company, which is company in the biopharmaceutical industry Country: United Kingdom			hospitalists, 50 nurse practitioners) IC= Medical Providers experienced with treating ABSSSI's, >18 years of age, must live in USA or United Kingdom EC= other professions beside medical provider, Lives outside of USA or United Kingdom		IV4- Identified an non-adherent if antimicrobial doses missed or missed appointment		IV2- Severe co-morbidities outpatient treatment probability <50% IV3- <75 years of age probability range of treating as outpatient decreased to 0.28 – 0.61. IV4- Not significant Findings: Severe comorbidities and age >75 years of age were important indicators of inpatient treatment	affect interpretation of results S: Eliciting treatment preferences from a variety of medical providers, providers recruited from a variety of practice types, large SS, experimental design demonstrated orthogonality and level balance. APP: Identifying key factors that affect ABSSSI's treatment plan. Highlights importance of severity stratification in

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								determining treatment of ABSSSI's.
Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Lee, G.C. (2016). A prospective observational cohort study in primary care practices to identify factors associated with treatment failure in Staphylococcus aureus skin and soft tissue infections. Funding: Pfizer	Normalization Process Theory, which is the theory of looking at complex interventions that have been put into place and evaluating them. This correlates with the treatment failure rate and risk	Design= PCS Purpose=To identify risk factors contributing to treatment failure associated with CA-MRSA SSTI's.	N= 106 patients M age= 41 M= 50% H= 74% O= 54% n= 84 (no treatment failure) M age= 40 M= 52% H=76% 0= 50% n= 22 (treatment failure) M age= 45 M= 41% H= 64%	IV1- MRSA phenotype IV2-MSSA phenotype IV3- Largest size diameter of the wound IV4- Duration of skin infection DV1- Treatment failure	IV1, IV2- + or negative blood cultures IV3- >5cm wound measurement IV4- number of days >7 days DV1- Measured by ER or	Bivariate Analysis P=< 0.05 Breslow Day test 95% CI	IV1- No statistical significance IV2- No statistical significance IV3- CI: 1.58-17.20. ES: 3.53 IV4- CI: 1.74-19.61. ES: 4.80 DV1- P= 0.32 Findings:	LOE: Level II W: Limited SS, social/behavioral risk factors not included, compliance of antimicrobials was no assessed S: First study to look at wound size as risk predictor, no bias, focused on primary care setting

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Conflicts/Bias: Pfizer could present bias on antibiotic treatment plans selected in this study since it is a pharmaceutical company. Country: USA	factors for this rate.		O= 71% SS= 14 primary care clinics in South Texas IC= Provided informed consent, at least 18 years of age or older and presented to one of the included clinics with a SSTI. EC= <18 years of age, no informed consent and no SSTI diagnosis. Treatment Failure definition: need for new antibiotic course/therapy, I&D, ER or hospital visit in post 90 days		hospital visit in post 90 days		MRSA infections do not have worse outcomes than MSSA infections. MRSA is not a reliable indicator of SSTI severity. Duration of infection and wound diameter were strongest risk predictors for treatment failure.	APP: Identify predictors for treatment failure can help target risk factors for severity of SSTI's. This study further strengthens the argument of time to effective treatment is a major factor in poor clinical outcomes and treatment failure

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Marwick, C. (2011). Prospective study of severity assessment and management of acute medical admissions with skin and soft tissue infection. Funding: None Conflict/Bias: None Country: Scotland	Levels of prevention model	Design: Retrospective cohort study Purpose: To identify patients with SSTI's to explore clinical management, illness severity and outcomes	N= 79 N1= 37 N2= 4 N3= 27 N4= 11 n= 1 SS= 2 hospitals in Scotland M=65% SI= 70% arm AGR= 37-69 IC= Patient's had to be seen for treatment between April 2009 and June 2010, >18 years of age, primary diagnosis of SSTI who received antimicrobials	IV1= Patients with blood cultures IV2= Patients without blood cultures IV3= Diabetes Mellitus IV4= Appropriate Treatment IV5= Inappropriate Treatment IV6= Age IV7= Charlson Index IV8= Severity Index IV9= SEWS	CREST Severity Scale Ki/Rostein Severity Classifications SEWS Classification	ANOVA Two-Way KAPPA test P<0.5 CI= 95%	IV1- no statistical significance IV2- no statistical significance IV3- CI: 0.98 – 1.31. OR: 1.13 IV4- CI: 0.41- 0.80 P<0.01. OR: 1.0 IV5- CI: 1.07-30.09 OR: 0.57	LOE: Level III W: Outside of US, 2 sites, Small SS, data 1 year, Level III S: significant results FE: Safe, easy to use index scales APP: Appropriate treatment, age, severity index, SEWS scale, SIRS scale affect

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			EC= Patients seen out of date range, < 18 years of age, lacking a primary diagnosis of SSTI	IV10= SIRS DV1= Mortality			IV6- P<0.07 IV7- P<0.27 IV8- P<0.004 IV9- P<0.002 IV10- P<0.266 DV1- Statistically significant	mortality. Implementation of these index/scales could decrease incidence of mortality in SSTI's.
Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Marwick. C. (2011). Prospective study of	Levels of Prevention Model	Design: Prospective Study Purpose: To	N= 79 n= 2	IV1=Timeframe antibiotics given IV2= Comorbidities	IV1- hours IV2, IV3,	Fisher's Exact Test Kappa	IV1- P<0.05 IV2- Not significant	LOE: Level II W: Small study population,

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severity assessment and management of acute medical admissions with skin and soft tissue skin infections. Funding: None Conflict/Bias: None Country: Scotland		prospectively identify patients with SSTI's presenting from the community, to document clinical management, illness severity and outcome	M age= 52 M= 65% SS= Acute Medical Admissions for 2 hospitals in Scotland IC=>18 years of age, primary diagnosis of SSTI who received antibiotics, admission between April 2009 and June 2010 EC= <18 years of age, no primary diagnosis of SSTI, admission outside of April 2009 and June 2010	IV3= Physiological Parameters IV4= Site of SSTI IV5= Size of SSTI IV6= Presence of absence of necrotizing fasciitis IV7= Severity of SSTI DV1= Adverse Patient outcomes DV2=Appropriateness of antibiotics	IV4, IV5, IV6- CREST severity classification, Ki/Rotstein criteria, Tayside Formulary DV1: measured as death within 30 days or re-admission to hospital within 30 days	Statistic CI= 95%	IV3- Not significant IV4- Not significant IV5- Not significant IV6- not significant IV7-not significant DV1= 6% DV2= P<0.01	small number of adverse outcome events S: Prospective design, ensuring the appropriate diagnosis for enrollment and ensuring no sampling bias FE: May not be feasible to apply to primary care setting APP: Over treatment of mild infections and under-treatment of severe SSTI's is a common practice that is

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								identified in the data. High incidence of wasteful investigation, time and resources to include blood cultures.
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Talan, D. A. (2014). Factors associated with decision to hospitalize emergency department patients with skin and soft tissue infections. Funding: Center's for	Multifactorial Causation Theory	Design: Prospective Cohort study Purpose: To identify factors that influences the physicians' decision to hospitalize a patient with a SSTI.	N= 619 n=1 SS= 12 USA ED's M age= 38.7 M= 57.5% AA= 51.5% CM= 32.5%	IV1= History of failed treatment IV2= A IV3= Comorbidity (Prior MRSA infection, Diabetes, chronic ulcer, edema, bed ridden) IV4=Infection type (abscess, cellulitis, infected wound)	Survey for physicians on reasons for admission and clinical characteristics	Statpages 2 way contingency table analysis CI: 95% Chi-Square Binary recursive partitioning	IV1= CI- 1.38 -3.72* ES: 1.76 IV2= CI-1.11-5.08* ES: 2.86 IV3= CI- 2.25-5.00* ES: 3.35 IV4=	LOE: Level II W: SS ED only, instrumentation used physician survey, did not take into account admission related to inability to preform wound care due to adl restrictions

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Disease Control Conflicts/Bias: None Country: USA			SSTI type: 85.1% abscess IC= >18 years of age, SSTI with symptoms <1 week, purulent exudate available for culture, ED patients only. EC= < 18 years of age, SSTI symptoms >1 week,	IV5 =Infection mechanism (chronic wound, infection of surgical wound) IV6= Infection location (groin, lower extremity) IV7=Symptoms (fever, chills, nausea/vomiting, extreme pain/tenderness, local edema) IV8=Size of wound IV9=Abnormal Imaging results IV10=Vital signs abnormalities (fever, tachypnea, tachycardia) DV1= Admitted with			CI- 2.31- 5.22* ES: 3.47 IV5= CI- 2.06 -6.77* ES: 6.77 IV6= CI- 1.13-2.49* ES: 1.69 IV7= CI- 2.92- 5.96* ES: 4.21 IV8= CI- 2.57 -6.62* ES: 4.09 IV9= CI- 1.42- 3.84* ES: 1.74 IV10= CI- 2.60-5.66*	S: Adequate sample size, variety of significant variables FE: Safe, low cost APP: Reasons physicians choose to admit a patient to the hospital for SSTI pertain to clinical characteristics of wound and patient history. A better understanding of reasoning behind physicians to hospitalize can help to streamline this process and admit unnecessary admissions from occurring.

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				SSTI DV2= Discharged with SSTI			ES: 4.02 DV1= Statistically significant DV2= Statistically significant	
Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Tiwari, A.K. (2014). Study to evaluate the role of severity stratification of skin and	Incidence, prevalence, mortality model Multifactorial	Design: Prospective cohort study Purpose: To explore the	N= 105 n 1=35 n 2= 70 SS= 1 hospital in New Delhi's	IV1= fever IV2= History of wound (trauma, animal or insect bite)	Department's Protocol Severity Stratification classification	Chi-Square Binary recursive partitioning P<0.05	IV1= <0.0001* IV2= 0.069* IV3= <0.0004*	LOE: Level II W: Small sample size, setting surgical outpatient,

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soft tissue infections in formulating treatment strategies and predicting poor prognostic factors. Funding: None Conflicts/Bias: None Country: New Delhi	causation theory	clinical profile of CA SSTI's, to evaluate the existing method of severity stratification and to identify factors for poor outcomes and lengthened hospitalizations.	surgical outpatient department and ED AGR= 15-71 M age= 41.2 M= 83.81 % IC= Presence of at least 2 of the following: swelling, erythema, severe pain, induration, abscess or tenderness to palpation. Presence of 1 of the following: body temperature > 40 Celsius <35 Celsius, WBC counts >15,000 or wound culture. Diagnosis of severe infection such NF EC= Patient with trivial injury, patient with hospital acquired	IV3= Gangrene IV4= BSA IV5= Loss of sensation DV1= Healthy wound DV2= Negative culture wound DV3= Unhealthy wound DV4= Positive wound culture			IV4= <0.001* IV5= <0.0365*	outside of USA population S: No Bias, Well described intervention, appropriate statistical analysis FE: Safe, Low cost APP: The existing severity stratification model does decrease healing time of SSTI's, but it could use some modifications that the Severity stratification model identified in this study. Based on the conclusions of the study, researchers

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			infection, <12 years of age, infection other than skin or soft tissue.					created an accurate algorithm for early detection, diagnosis and treatment.
Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement / Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Wilson, S.M. (2011). A severity score for complicated skin and soft tissue infections derived from phase III studies of Linezolid. Funding: Pharmacia and Upjohn Conflict/Bias: Study is funded by pharmaceutical	Incidence, prevalence, mortality model	Design: Prospective comparative Randomized trial Purpose: To develop and implement a severity scoring system for SSTI's and to identify factors contributing to treatment failure.	N= Study A- 632 Study B- 334 n= A- 133 B- 38 M age= A-16.8 B-49.2 C= A- 56.8% B- 88.5% M= A-63% B-46.9%	IV1= Comorbidities IV2=BUN IV3= Sodium IV4= Hematocrit IV5= Lesion size IV6= Surgical wound infection IV7=Linezolid intervention IV8= Comparator group	IV1-IV7= Modified Fine Severity Scoring Model IV2= >30 IV3= <130 IV4= <30% IV5= <150cm DV1= measured by number of days/number of doses of treatment until s/sx improved.	Logistic Regression P= <0.05	IV1= P= <0.1 IV2= P= 0.023* IV3= P= 0.036* IV4= P= 0.002* IV5= P= 0.009* IV6= P= 0.039*	LOE: Level II W: Study criteria excluded uncomplicated SSTI's, necrotizing fasciitis and diabetic foot ulcers. Not all variables included that could influence outcome in severity scale. Only applied to hospital population, not

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companies which may influence their recommendations on the use of antimicrobial therapy Country: USA			SS= A- 133 sites in USA, Latin America, Asia B- 38 sites in Europe, South Africa IC= hospitalized, Gram + complicated SSTI, signed consent form EC= Uncomplicated SSTI, Outpatient setting, Other organisms besides Gram +	DV1= Lower Clinical Cure Rate Complicated Definition: infections extending into the deeper tissue and requiring systemic antibiotic therapy and surgical interventions Clinical Cure definition: Resolution of baseline s/sx of infection or improvement after at least 5 days and 20 doses of study medication. Clinical Failure definition: Persistence or progression of s/sx of infection after at least 2 days and 8			IV7= P= 0.001* IV8- Not significant DV1= P=0.001* Findings: Comorbidities significantly decrease cure rate. BUN, sodium, hematocrit, lesion size and presence of surgical wound infection are clinically significant factors in clinical cure rates. Clinical cure rates were lower in patients who disease scores below the median and who	primary care. S: Large SS, Level II evidence APP: This scoring tool provides a practical tool for assessing patients with complicated SSTI's and identifying those who may need more aggressive support. This scoring system can be used as an overall guide to overall prognosis and to the level of medical/surgical treatment.

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				doses of medication			were in the high-risk classes.	

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Appendix E

Synthesis Table: Severity/Risk Stratification Scales in SSTI's

Author										
	Figtree	Hashem	Jenkins	Lane	Lee	Marwick	Marwick	Talan	Tiwari	Wilson
Study Characteristics										
Year:	2012	2016	2011	2016	2016	2011	2012	2014	2014	2011
Design:										
Retrospective Cohort	X	X	X			X				
Prospective Cohort					X		X	X	X	X
Cross Sectional				X						
Setting:										
Community			X	X	X					X
Inpatient	X	X	X	X		X	X	X	X	X
Population Demographics										
Sample:										
Number of sites	1	1	1	N/A	14	2	2	12	1	133, 38
N	395	200	344	400	106	79	79	619	105	632, 334
Duration	7 y	1 y	2 y	NI	NI	15 Months	15 months	NI	NI	NI
Demographics:								*		
Age (mean)	70.6	54	CO-46 I- 47	USA-45 UK-42	41	AGR-37-69	52	38.7	41.2	16.8, 49.2
Male Gender (%)	43%	53%	CO- 75% I- 66%	USA-64.5% UK- 70%	50%	65%	65%	57.5%	83.81%	63%, 46.9%
Tools used:										
Risk severity stratification tool	X					X			X	X
Standardized treatment plan			X							
CREST		X				X	X			
SEWS		X				X				
Severity of acute bacterial SSTI's				X						
Ki/Rotstein						X	X			

CREST: Clinical resource efficiency support team, **N:** sample size, **SEWS:** Standardized early warning score, **SSTI's:** skin and soft tissue infections, *: Statistically significant

Systemic inflammatory response syndrome						X				
Charlson Index						X				
Independent Variables										
Age	X*			X*		X*		X*		
Co-Morbidities	X*			X*		X*	X	X*		X
Duration of symptoms	X*				X*					
S/SX		X*		X*			X	X*		
Wound Size	X*				X*			X*	X*	X*
Vital signs								X*	X*	
Measurable Outcomes										
Length of hospital stay	X		X	X						
Complete response		X					X			X
Duration of therapy			X							
Re-hospitalization rate	X		X	X			X			
Outpatient treatment				X				X		

CREST: Clinical resource efficiency support team, **N:** sample size, **SEWS:** Standardized early warning score, **SSTI's:** skin and soft tissue infections, *: Statistically significant

Appendix F

The Advancing Research and Clinical Practice Through Close Collaboration (ARCC) EBP Model