Skin and Soft Tissue Infections: Improving Treatments for the Incarcerated Population

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Abstract

Skin and soft tissue infections (SSTIs) occur at higher rates within correctional facilities due to the increased risks that are inherent in this population. These infections present at various stages, requiring different treatment modalities and sometimes require complex treatment. Prompt and accurate recognition of SSTIs is crucial in selecting appropriate treatment to decrease the possibility of treatment failure. Literature shows a correlation between diagnosis delay and increased time and overall cost of care related to delayed diagnosis of SSTIs. These findings support the implementation of an evidence-based project which aims to determine whether the utilization of an algorithm for SSTIs can be amplified through increased accessibility.

Keywords: SSTI, skin infections, skin and soft tissue infections, protocols, correctional facilities, treatment failure

Skin and Soft Tissue Infections: Improving Treatments for the Incarcerated Population

Skin and soft tissue infections (SSTIs) are a common yet potentially life-threatening condition. They are difficult to identify and have the potential to be costly to treat or have poor long-term outcomes if misdiagnosed. In correctional health care facilities, the rate of treatment failure and recurrence directly causes an increase to overall costs to the health care system, making this issue important to examine. Populations at greatest risk for SSTIs include the incarcerated population, who have multiple risk factors which lead to the development of these infections. When pathogenic organisms enter the protective barrier provided by the skin, infections can occur which may or may not be self-limiting. Tissue damage is evident when the area presents with warmth, edema, erythema, and often pain (Aly, 1996). SSTIs often present in this manner and are categorized into two groups, purulent and non-purulent and then subcategorized depending on level of severity as mild, moderate, or severe. Treatments for purulent and non-purulent infections depend on severity as well as patient history, therefore, established guidelines should be followed to ensure treatments are chosen accordingly.

Currently, guidelines from the Centers for Disease Control and Prevention (CDC) as well as the Infectious Diseases Society of America (IDSA) provide structured treatment of SSTIs and are revised periodically based on epidemiological data, statistics, and the most up to date research. SSTIs continue to afflict individuals despite prevention campaigns. Protocols such as algorithms can help delineate the various treatment options in place and can assist providers in caring for these patients before infections become complicated. SSTIs are endemic amongst incarcerated populations; unfortunately, algorithms are seldom available for the health care providers to follow (David & Daum, 2010; Dellit et al., 2007; Dhar, 2018; Ellias, A.F.,

Chaussee, M.S., McDowell, E.J., & Huntington, M.K., 2010; Federal Bureau of Prisons, 2012; Grief, 2017).

Background and Significance

SSTIs include impetigo, cellulitis, folliculitis, carbuncles, abscesses, pyomyositis, orbital cellulitis, and necrotizing fasciitis (Popovich & Hota, 2008). Normal skin flora, including bacteria, are found on the superficial layers of the epidermis typically preventing pathogenic organisms from colonizing the skin (Aly, 1996); however, these organisms can become dangerous if they have an entry point into the body. The most common pathogens for skin infections are Staphylococcus and Streptococcus, with Methicillin-resistant Staphylococcus aureus (MRSA) being the most common pathogen causing skin infections in the United States (US), and account for over half of the community-associated SSTIs (Dhar, 2018).

The CDC estimate over 80,000 invasive MRSA infections with resultant 11, 285 deaths per year world-wide (CDC, 2014). In efforts to further track the number of MRSA infections, both international and national organizations have encouraged MRSA case tracking by including this in the National Healthcare Safety Network (NHSN) reportable disease category. In Arizona, the number of MRSA cases for 2017 was 1,357, which was almost 100 more than the previous year (Arizona Department of Health Services, 2018). There are factors which predispose individuals to develop SSTIs including: living in close quarters, previous skin infection, nasal colonization of MRSA, intravenous drug use, and previous infection (Grief, 2017; Liu et al., 2008; Raff & Kroshinsky, 2016). Incarcerated individuals are at increased risk for SSTIs due to the presence of multiple risk factors simultaneously. These include any combination of the following: living in crowded cells/rooms, higher number of inmates having their anterior nares colonized with MRSA, personal history of SSTIs with subsequent exposure to antibiotics, not

finishing their treatment course due to becoming incarcerated, and being exposed to these organisms due to hospitalizations for other illness (Dober, 2014; Ellias, et al., 2010; Herman, R.A., Kee, V.R., & Moores, K.G., 2008; Lee et al, 2011).

Problem Statement

The growing problem of SSTIs has surged due to the rising number of pathogens becoming resistant to established treatments. Multiple drug resistant organisms (MDROs) such as MRSA can be limited by the implementation of antibiotic stewardship programs, choosing the proper treatment for each infection per the recommended guideline and properly utilizing established tools, such as algorithms, for the treatment of infections for incarcerated individuals (Federal Bureau of Prisons, 2012; Stevens et al., 2014; Wlodaver & May, 2017). Current research demonstrates that a primary barrier for effective diagnosis and treatment of SSTIs is a lack of standardized tool use (Lee et. al., 2016; Mullen & O'keefe, 2015).

The incidence of SSTIs raise additional concerns with the incarcerated population. For example, incarcerated individuals often possess low levels of literacy which would make initiatives for the reduction of infection difficult to read and comprehend (Grief, 2017). Also, incarcerated patients pose an additional challenge to providers because of the inability to isolate patients with known infections due to the mandatory living conditions of shared cells and limited access to personal hygiene items. This in turn contributes to the spread of infections (Datta & Juthani-Mehta, 2017). Lastly, inmates face the challenge of obtaining appropriate health care due to only seeing providers once their condition is deemed urgent according to the nurses' assessment which can delay the identification of SSTIs leading to rapid progression and increased complications, including death (Dober, 2014).

A population-based study in San Francisco demonstrated that 85% of MRSA cases occurred outside a health care setting (Liu et al., 2008). A retrospective analysis of 986 hospitals in 33 states and 994 hospitals in 28 states concluded that bacteremia resulting from MRSA has increased mortality rate twice as high for inpatient treatment (Noskin et al., 2005). As a result, in the US, the CDC issued guidelines for the treatment of MRSA in October of 2006 (CDC, 2014). Despite availability of current guidelines for clinical practice, not all organizations housing at-risk individuals have active policies or protocols which may help them determine an appropriate plan of care for new SSTIs. This is particularly true of jails and prisons, which house a large number of individuals that have frequent and/or recurrent SSTIs (David & Daum, 2010; Ellias, et al., 2010; Grief, 2017; Herman, R.A., Kee, V.R., & Moores, K.G.,2008).

There are similarities in the clinical presentation of skin infections and depending on staff knowledge and experience, there may also be limitations in the ability to adequately identify the causative organisms in a timely manner; delaying the diagnosis and treatment of SSTIs (Raff & Kroshinsky, 2016). High staff turn-around, lack of continuity of care due to rotating providers through various organizations, jail/prison restrictions related to limited content allowed within charts, length of time elapsed prior to being seen by providers, and limited pharmacological agents available for in-house treatment pose barriers to implementation of algorithms for treatment of SSTIs for incarcerated populations.

Careful assessment of incarcerated population risk factors can lead to prompt identification of SSTIs based on degree of severity during the provider's initial history taking and physical examination (Chahine & Sucher, 2015). Provider ordered daily wound care can be utilized to track the improvement of a SSTI and can also help decrease complications. One such outcome which would show improvement in the treatment of SSTIs in this population would be

the reduction of infections requiring incision and drainage (I&D) treatment, which is usually reserved for complicated cases (Raff & Kroshinsky, 2016). Another complication of under-treated SSTIs is treatment failure, characterized by no improvement seen after finished course of antibiotics. Treatment failure can be identified by enlarged area of erythema, increased purulence production, and systemic symptoms. If treatment failure occurs, the provider can decide on the necessary course of action to ensure the SSTI is successfully treated, even if it requires inpatient hospital treatment (Labreche et al., 2013; Noskin et al., 2005; Wlodaver & May, 2017). These complications have been shown to be reduced by antimicrobial stewardship programs and may be further improved through implementation of interventions that will allow for the following of algorithms as they will decrease the number of inappropriate antibiotic treatments (Carrerra, E., Pfeffer, I., Zusman, O, Leibovici, L, & Paul, M., 2017; Dellit et al., 2007).

One of five patients experience treatment failure and will likely require additional interventions at an associated cost of almost $2,000 per patient (Labreche et al., 2013). This does not include the costs unique to a correctional facility as it relates to prolonged in-house treatment, staff who must accompany an inmate for off-site treatment, transportation, and any potential hospital costs for inpatient care, supplies, and medications; expenses which are the responsibility of correctional health services. An additional cost can also be accrued if the patient presents with new areas of infection as a result of spreading the infection to other parts of the body. With early identification and prompt treatment, these costs can all be reduced.

In a correctional facility in the Southwestern US, an SSTI algorithm was recently instituted to facilitate the early identification and prompt treatment of these type of infections due to their frequent presentation. Despite a successful presentation to the providers at mandatory staff meetings, there were several barriers identified which may interfere with the algorithm

being utilized optimally. One barrier identified was that not all current providers were present during the presentation. In an effort to further promote the use of the algorithm amongst current health care providers, the question that must be answered is how to disperse the tool to all new and rotating staff members. Additionally, patient perspective should be taken into account in regard to anticipated outcomes vs cost of treatment. In this facility, inmates pay $5 for a nursing visit, $10 for healthcare provider visit, and $5 per medication ordered. While this may not appear to be a significant cost, inmates receive no income, may or may not receive money from family, and must choose between paying for health care costs or buying personal items they might need from detention services. If providers encounter barriers to implementing current guidelines, the treatment may be extended and the outcomes may be compromised due to the high prevalence of MDROs (Carrara et al., 2017). The promotion of current recommendations, including tools such as algorithms may amplify the implementation of best practices and is key in curtailing the effects of SSTIs (CDC, 2011), specifically in the incarcerated population.

Absent or inconsistent use of existing tools for the diagnosis and treatment of these types infections has led to the clinically relevant question: when treating incarcerated adults, does placing a copy of a pre-existing algorithm in each exam room improve the rate of utilization of the algorithm for providers for treating individuals with a SSTI diagnosis over a two-week period?

Search Strategy

In an attempt to establish the current use of algorithms in correctional facilities for the treatment of SSTIs, an exhaustive search was performed. Literature review was performed after the following databases were searched: Elton B Stephens Company host (EBSCO host), PubMed, PsycINFO, and the Cochrane Library. The keywords utilized were “protocol”, “clinical

judgement", "skin infections", "jails", and "prisons". There were limits utilized which included adult population, systematic reviews, meta-analysis, randomized control trials, and publications within the last five years. Initially, some searches were yielding no results, so it was decided to include Boolean phrases and MESH terms that may increase the yield. These terms included "correctional facilities", "institutions", "algorithms", and "improved outcomes". Inclusion criteria for the studies included those with adult populations, populations living in close contact, and those with established protocols/guidelines for treatments provided to this population. Exclusion criteria included: studies greater than ten years old and population less than eighteen years old. The Boolean phrase term search on EBSCO host yielded 523 results (Appendix A). The search was refined to include "improved outcomes" and "guidelines" and thus yielded a final 17 studies.

The MESH terms method used for PubMed found 15,629 articles (Appendix B). It was then decided to change the order of the terms and to filter based on type of article published to reviews, clinical trials, and meta-analysis. This narrowed the findings to 822 and was furthered refined by choosing the title/abstract as the location for the keywords which resulted in a manageable 28.

The search done in PsycINFO which included the keyword "algorithm" resulted in 1,134 findings (Appendix C). It was decided to replace this term with "clinical judgement" as this portion of the topic still needed to be addressed. This reduced the number of publications to 453 and limits on type of publication and year of publication were added which produced a manageable result of ten.

Performing a search within the Cochrane Library was different than the other databases. In order to obtain any results, the filters were set to include studies within the last 20 years and

the keywords utilized were limited to “jail”, “protocol”, and “inmates”. The results were only twelve (Appendix D). The final analysis included 10 publications that were selected based on their relevance and high level of statistical significance to the topic at hand.

Evidence Synthesis

A total of ten studies were selected for the literature review. Following evaluation utilizing the rapid critical appraisal method, data was extracted, summarized, and placed in an evaluation (Appendix E) and synthesis table (Appendix F). The strength of the studies was moderate as it included publications of all levels of evidence including: two level I, three level II, three level III, and two level IV (Melnyk & Fineout-Overholt, 2015). The studies included two systematic reviews, two retrospective cohort studies, one randomized control trial, three observational studies with chart review, and one quality improvement project (Appendix F).

Although settings outside of correctional health were utilized, it was due to the lack of studies performed in this particular setting. Alternate settings were selected due to their inclusion of prisoners, which allowed to study this specific population. Of the studies, few cited theoretical frameworks or models, but the ones that did predominantly chose the Multifactorial Causation Theory or the Levels of Prevention Model. Each publication was chosen due to the discussion, inclusion, or relevance it had in relation to incarcerated populations. Less than half of the articles utilized measuring instruments with associated specificities or sensitivities (Appendix E), which was expected as none of them discussed an accepted protocol/algorithm utilized for the incarcerated population.

Four of the articles did utilize reliable and valid tools to help demonstrate the statistical significance of utilizing established tools in the treatment of this population (Appendix E). Possible bias was noted in two studies, one whose author was employed the funding company

and another who was reimbursed for each patient they enrolled in the study. However, upon further research, it was noted that the studies in question did not support use of specific medications, instead, they both highlighted the importance of proper identification of infections in order to reduce length of treatment and cost per patient (Appendix E). The studies which took place in hospitals focused on the difference between treating as an outpatient versus treatment failure as a result of inadequate antibiotic therapy leading to hospitalization. The majority of the studies took place in the US, increasing the generalizability of the findings to the population of interest since the percentage of incarcerated individuals in the US has increased by 300% since 1980 (Mullen, L. A. & O'keefe, C., 2015).

The sample population focused on incarcerated adults or those with similar demographics, with a definite inclusion limited to adults greater than 18 years old. The majority of the studies highlighted the positive outcomes associated with ensuring timely antibiotic treatment through the use of following established guidelines. As a whole, the studies discussed challenges that may be present while prescribing medications within correctional facilities, while three focused on the implementation of antibiotic stewardship programs (Appendix E). Overall, the study findings established the importance of appropriate antibiotic therapy when treating infections in incarcerated populations related to overall cost savings and decreased complications.

Despite available treatment guidelines and the current number of SSTIs worldwide, in 2016, the CDC released a list of organisms which pose even greater threats to public health in an attempt to highlight the importance of multi-drug resistant organisms (MDROs) worldwide (CDC, 2014). The facts include both the number of cases reported of the most common MDROs as well as the number of deaths which are a direct result of these organisms (CDC, 2014). The

CDC supports preventive efforts, prompt recognition, and aggressive treatments of infections with a main goal of reduction in mortality. Similarly, the ISDA strives to update guidelines for the treatment of SSTIs periodically due to the prevalence of MDROs and limited number of antibiotics which have been found to successfully eradicate these organisms (Stevens et al., 2014). These guidelines acknowledge the necessity and efficacy of different treatment options and support them according to the severity of the infection. To best disburse these guidelines, algorithms are put in place to ensure the same process is being followed by all providers within a health care organization. An effective approach would include having the algorithm readily available for providers to reference during each face-to-face encounter and utilizing it for deciding treatment for every infection (Hashem, N. G., Hidayat, L., Berkowitz, L., & Venugopalan, V., 2016).

Purpose Statement

An evidence-based project was designed to increase the accessibility of an algorithm for the treatment of SSTIs in a correctional facility in the Southwestern United States in order to increase adherence to treatment guidelines for SSTIs. The change to current practice will be incorporating the tool into each patient-provider visit by placing a copy in the exam rooms in an attempt to increase its use and thus improve the outcomes of prisoners with a SSTIs diagnosis.

Quality Improvement Model

The Model for Improvement Plan, Do, Study, Act (PDSA) will enable the change to current clinical practice. This model is utilized in health care as a step driven guide to improve current practices. It begins by analyzing the current practice and coming up with a proposed plan to change it. The next step is implementing the plan and gathering the data to be able to demonstrate the change was implemented. After a pre-determined time has passed the data

would be reviewed, summarized, and evaluated to ensure no changes are necessary (Langley et al., 2009). Following this model would facilitate the implementation of a project within a large organization as it allows for evaluation and critique of current practices with subsequent analysis of any barriers which may arise before actually implementing the proposed project. Also, the PDSA is appropriate to use within different facilities as there may be organizational changes specific to different environments that may not be foreseen but can be addressed after the project is implemented. The cyclical nature of this model allows for any necessary modifications to be made if the results of the project are inconsistent with expected results and can allow the organization to pinpoint what step needs to be changed (Appendix H).

Conceptual Framework

Increasing the use of an established algorithm within correctional facilities would require three factors to be considered: the setting, the health care providers, and the treatment being provided. The Social Cognitive theory underpins this project as it focuses on environment, people, and behavior (Bandura, 2001). This theory supports the idea that these three factors are constantly influencing one another and they cannot be independent of each other (Appendix G). Additionally, it supports that the capability of an individual to endorse a particular behavior with the assumption that they have been given the proper information and possess the knowledge to perform it adequately. Hence, it would translate into clinical practice by requiring health care providers to understand, acknowledge, and implement the algorithm for each patient presenting with a SSTI. This theory would further support a practice change by promoting learning through the observation of others. Therefore, even in an environment where there are multiple providers caring for the same patients, following the algorithm would be more likely if providers have access to the same tool for each encounter. Thus, the logic of altering the environment of the

visits would increase the provider use of the algorithm and subsequently improve the treatment of prisoners with SSTIs.

Project Methods

The project was drafted, submitted, and received IRB approval by Arizona State University as well as support by the facility medical director. The setting for the project was a correctional facility in the Southwestern United States which houses more than 2,300 prisoners on a daily basis. This facility was selected as it was part of a larger organization which had an algorithm developed previously to assist their providers in selecting appropriate treatments for SSTIs. Despite a receptive attitude amongst the medical director, providers, nurses, and ancillary staff of the algorithm, it was discovered the use of the algorithm was not being monitored and the rate of turnover was very high which appeared to be limiting the use of the algorithm.

The project coordinator determined providers were the frontline when implementing the algorithm correctly and as such they were recruited to participate in the project. A survey was developed by the project coordinator which would anonymously gather demographic information, determine whether the providers had knowledge of the existence of the algorithm, utilize a Likert scale for providers to rate their current use of the algorithm, and to ask providers what they felt were the current barriers to using the algorithm. In order to secure their participation, they were assured that their responses to the survey would be anonymous and tracked with 4-digit identification numbers that only the project coordinator would have access to. Consent was implied via completion of the survey by providers, thus, this part of the project consisted of hand-delivering the surveys. The providers were allotted enough time for completion and after the information was tabulated, it was determined that the main barrier for utilization consisted of a lack of accessibility.

From there, the intervention of placing the algorithm into the electronic medical record was decided. However, due to financial limitations, this option was not feasible. A modification was made to the initial plan by choosing a more affordable option: making full-size, laminated copies of the algorithms and placing directly in all exam rooms for providers to have available for each face-to-face encounter. This proved to be a better option for this facility as the budget to implement the project consisted of spending a mere $20 US dollars.

In order to determine utilization of the algorithm, it was necessary to perform a retrospective chart analysis. Prisoner charts were reviewed over a 2-week period pre and post intervention to identify those who had a SSTIs diagnosis. Each prisoner chart was given a five-digit identification number on a spreadsheet which was used to keep the necessary data and had no patient identifiers linked to the original charts. To effectively qualify as having used the algorithm, the provider had to include the following components: adequate diagnosis, proper antibiotic selection, and if indicated, wound care orders. Measurement outcomes were obtained by giving each prisoners' chart a subject number without including any individual identifiers. After the data was validated, it was coded and both the survey and chart review results were analyzed utilizing SPSS version 25. Comparing the pre and post intervention rate of utilization was done by calculating the number of cases of SSTIs that were properly treated with the algorithm in each 2-week period before and after the intervention. A tally was also kept of the total number of SSTIs diagnosed for the duration of the project.

Outcomes/Project Results/Impact

Provider participation only yielded eight participants. Their ages ranged from 29-57 years old with four identifing as females and four as males. Amongst them, one was a physician, two were nurse practitioners, and five were physician assistants. Of the eight providers, only three

reported having knowledge of the existence of the algorithm prior to the intervention and even then, only two of them reported using it “sometimes” for the treatment of SSTIs. Overall, the provider responses indicated that if they could see the algorithm during visits, they would use it more often. After the intervention, the same providers were surveyed and seven of the eight endorsed the algorithm as a tool they used “frequently” when treating SSTIs.

The total number of charts reviewed was 97. For statistical analysis, the Pearson Chi Square two-tailed test was utilized as it is suitable for unpaired data sets when testing a null hypothesis, with $p< 0.05$ indicating significance. If the p-value is larger than the significance level, you fail to reject the null hypothesis because there is not enough evidence to conclude that the variables are associated (Keller & Kelvin, 2013). The results were calculated via SPSS version 25 and yielded $p= 0.137$, showing non-significance.

Prior to intervention, there were 55 SSTIs diagnosed, 18 of which met algorithm criteria; therefore, the rate of utilization was 32.7%. For the post intervention period, there were 42 SSTIs diagnosed with 20 meeting algorithm criteria. This showed an increase of 14.9% use of the algorithm amongst all providers. This was clinically significant because it correlated with the provider responses post-intervention of increased use of the algorithm.

Additionally, it was noted that there was a 23% decrease in total number of SSTIs diagnosed during the post intervention period. This was clinically significant as it could be related to adequate initial treatment leading to a decrease in number of treatment failures (Carrera et al., 2017; Kamath, et al., 2018; Labreche et al., 2013; Lane et al., 2016).

Discussion

Demonstrating the positive effects of utilizing algorithms for the treatment of SSTIs can promote a change to the current practice within correctional facilities. The change to current practice will ensure correctional health care providers are following the most current guidelines when treating SSTIs which will be supported with a marked reduction in treatment time, decrease in complications, and decreased costs. These benefits will positively impact the prisoners, the providers, and the correctional facilities who choose to implement this change. This project intervention has minimal costs when compared to the long-term savings that will be seen by the facilities and organizations who do not currently follow the practice of utilizing algorithms in the treatment of SSTIs.

Limitations of this project consisted of small sample sizes and short intervention period, both can be explained by the setting of the project and the amount of time it takes to receive IRB approval in these types of facilities. Future studies should be done in larger facilities, over a longer period of time, and be based on the most up-to-date guidelines. Sustainability of the project would consist of monitoring for any updates made to current recommendations in the treatment of SSTIs and then changing the algorithm accordingly. These updates are only necessary every couple of years, when the CDC or IDSA release their new guidelines, and this can be delegated to the education coordinator of each facility which minimizes the costs and maximizes its savings. The algorithm will be presented to all providers during the on-boarding process to ensure they are educated about its existence and availability.

Conclusions

Despite current treatment guidelines in regard to SSTIs in the general population, there exists no established protocol for implementation of these guidelines for special populations such

as those in correctional facilities. The studies suggest a need for providers to be consistent when treating infections, particularly when it involves resistant pathogens due to the complexity of their treatment. The research does not discuss whether the guidelines from one organization would be better than another, it simply supports that utilizing guidelines is recommended as it decreases the risk of complications and promotes improved outcomes. The research reviewed indicates that health care providers working in correctional facilities should implement SSTI treatment guidelines using a standard approach, which can easily be done when following a pre-established algorithm. If the implementation of algorithms continues to be promoted and results are recorded, this practice can be adopted throughout all correctional facilities in the U.S.

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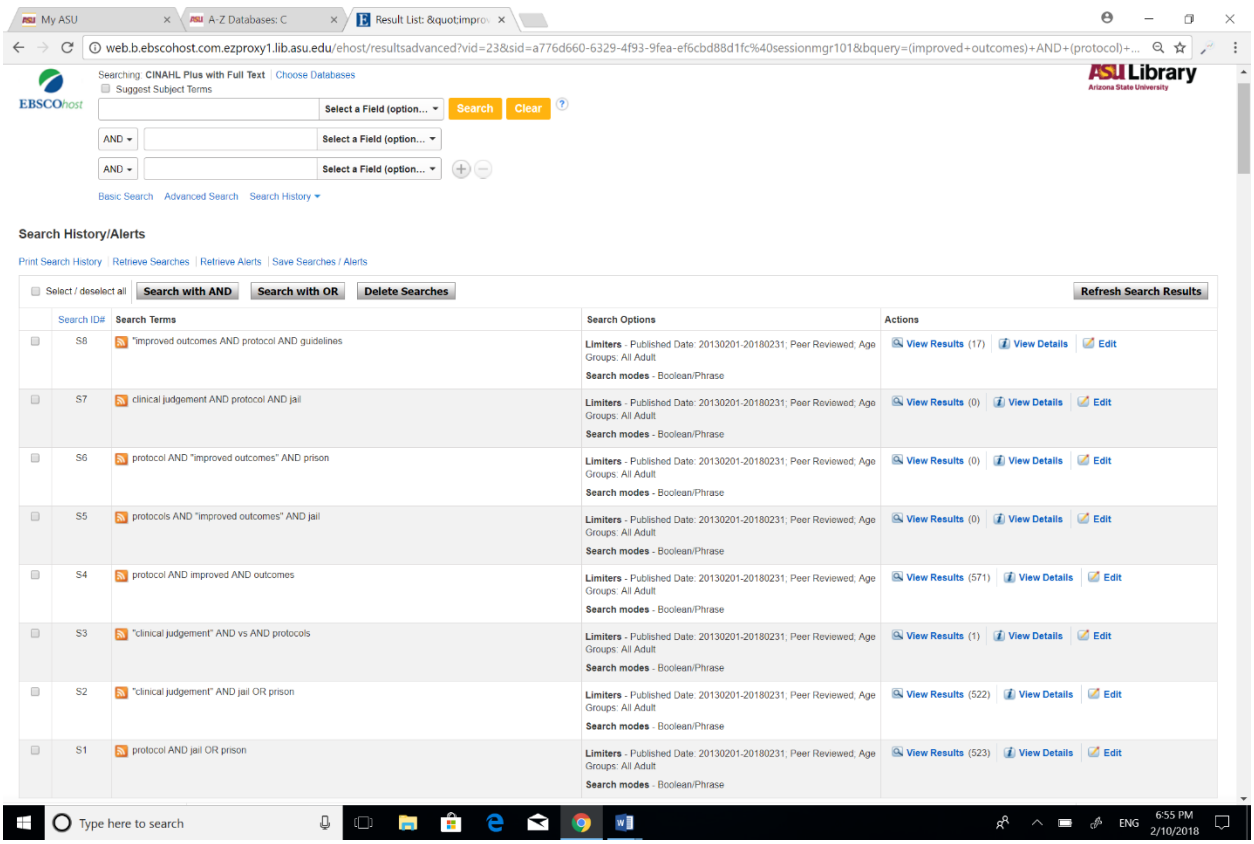
Stevens D.L., Bisno A.L., Chambers H.F., Dellinger, E.P., Goldstein, E.J., Gorbach, S.L., … Wade, J.C. (2014). Practice guidelines for the diagnosis and management of skin and soft tissue infections: 2014 update by the Infectious Diseases Society of America. *Clinical Infectious Diseases, 59*(4), e10-e52.

Talan, D. A., Salhi, B. A., Moran, G. J., Mower, W. R., Hsieh, Y., Krishnadasan, A. & Rothman, R. E. (2014). Factors associated with decision to hospitalize emergency department patients with skin and soft tissue infections. *Western Journal of Emergency Medicine*, 1, 89-97.

Wlodaver, C.G. & May, C. (2017). Antibiotic stewardship for non-infectious disease physicians: Focusing on when to withhold, modify, and discontinue antibiotics. *The Journal of the Oklahoma State Medical Association, 110*(1), 8-12.

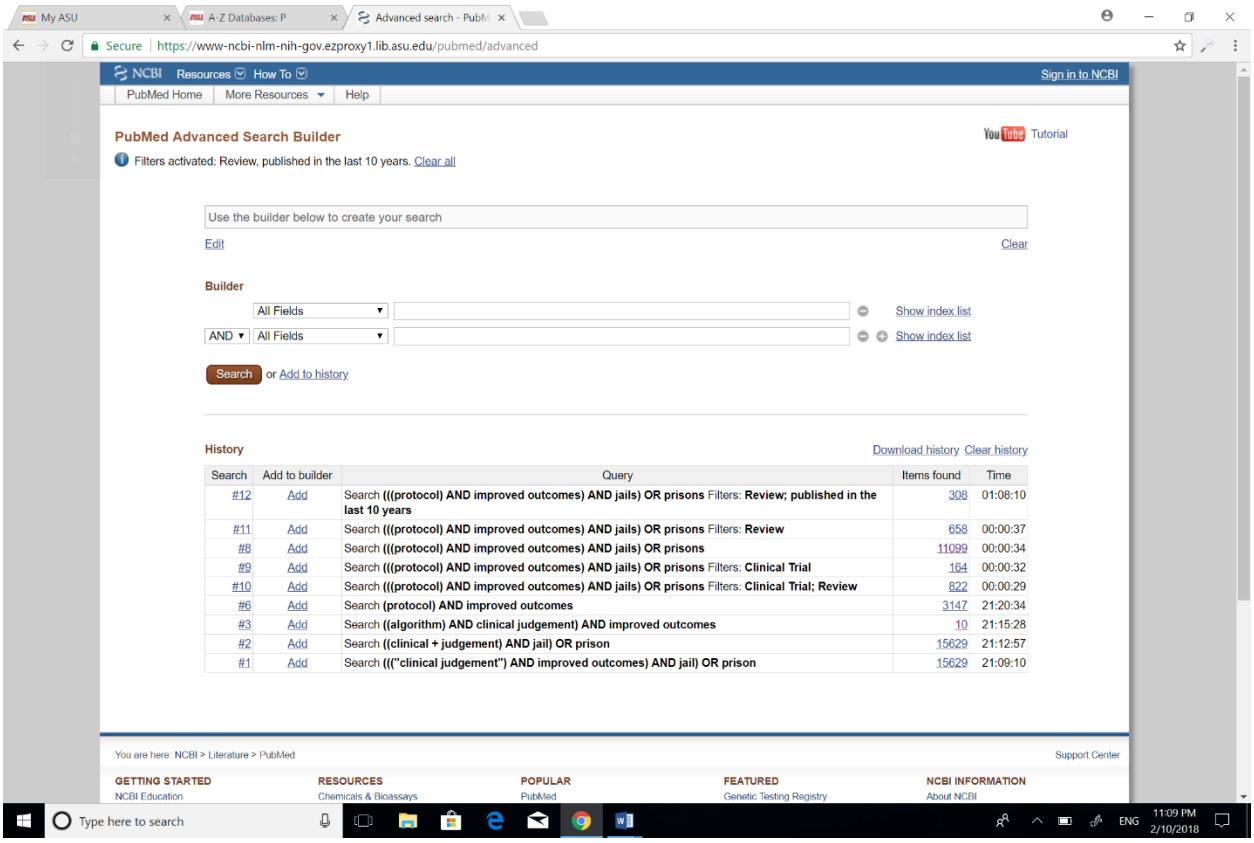
Appendix A

EBSCO host search



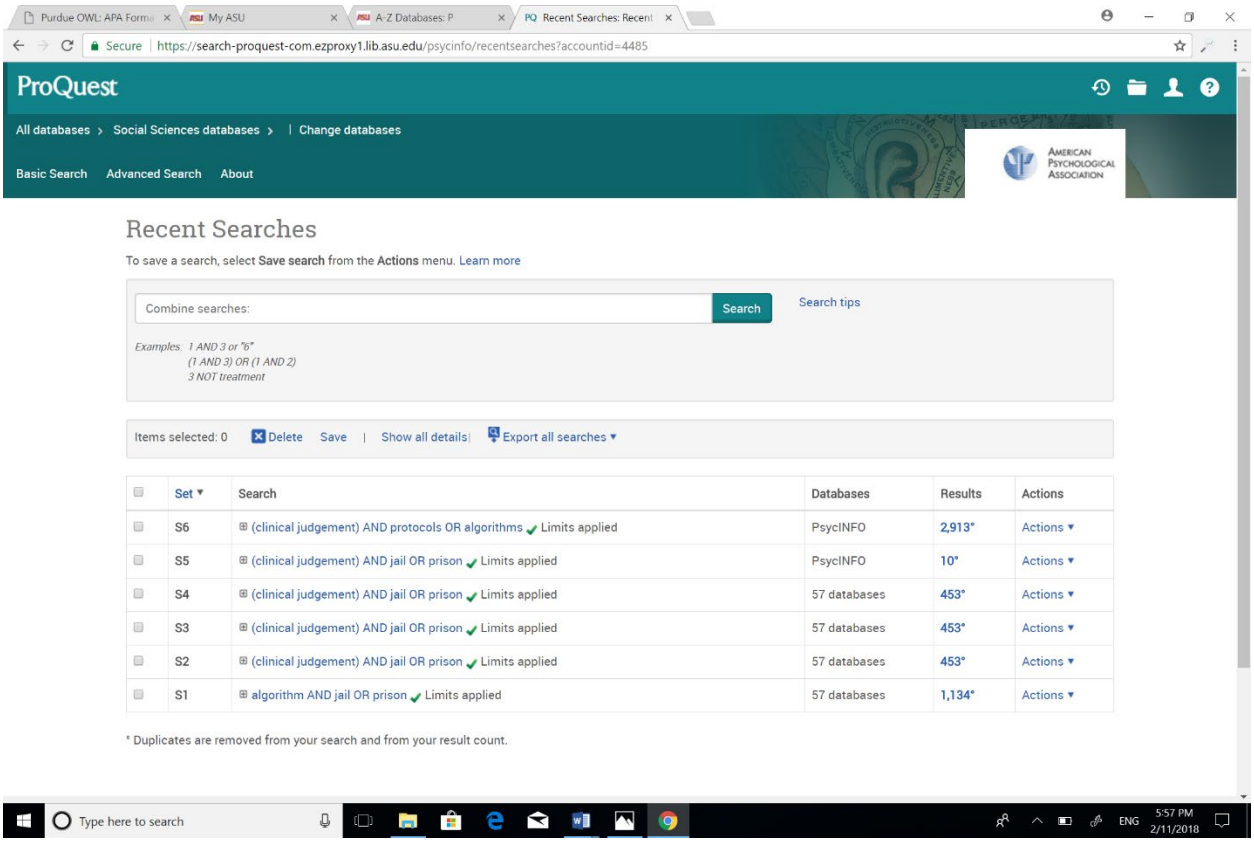
Appendix B

PubMed search



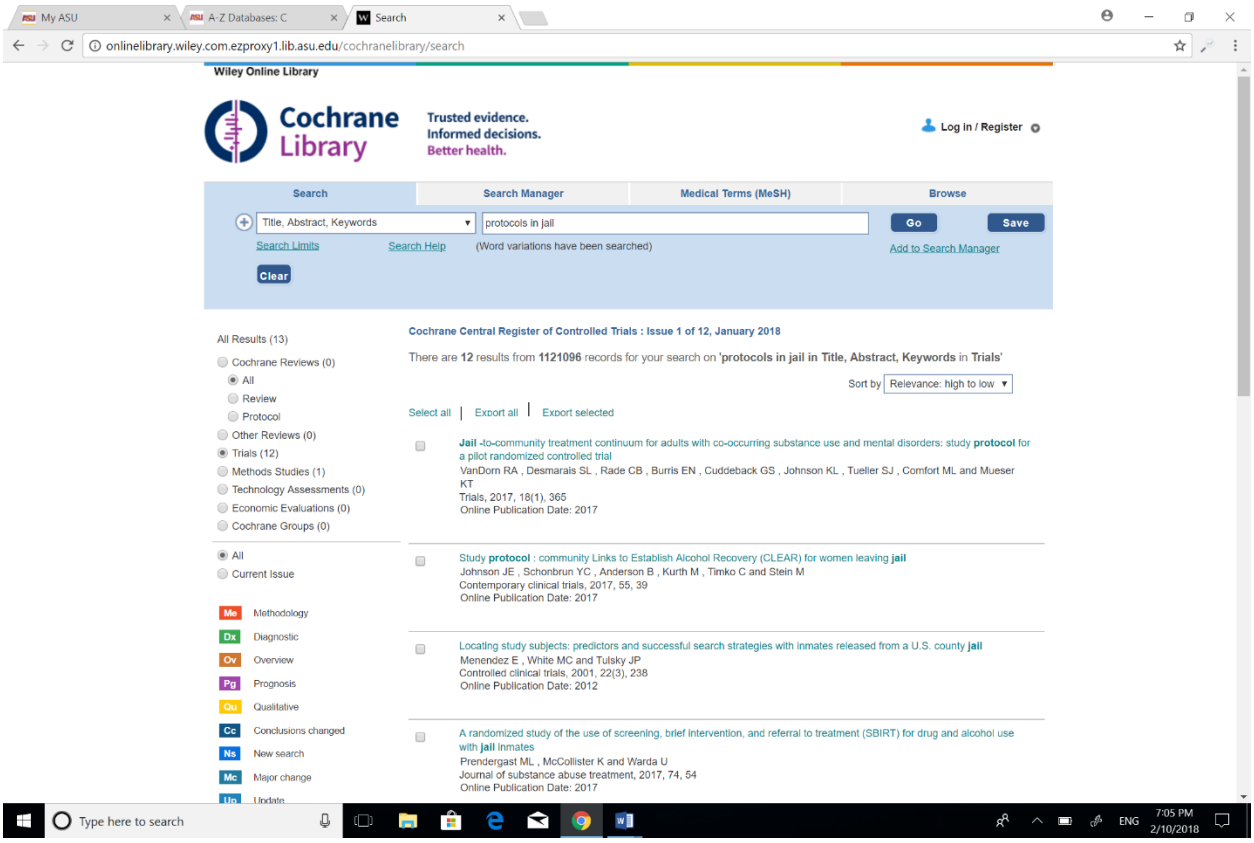
Appendix C

PsycINFO search



Appendix D

Cochrane Library search



Appendix E

Table 1

Evaluation Table

Citation	Theory/conceptual framework	Study 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
Carrara et al. (2017). Determinants of inappropriate empirical antibiotic treatment: a systematic review and meta-analysis. Funding: Israeli Ministry of Science, Technology & Space research grant Conflicts/bias: none	Multifactorial causation theory	Systematic review Purpose: assess the determinants of inappropriate ABX tx	N: 168 studies n= 73,595 S: studies cited from multiple countries IC: > 18 yrs old, documented bacterial infections EC: studies with < 50 pts, studies where infections were deemed to need long-term ABX tx	IV1: prevalence of MDRO IV2: IEAT DV: association between IV's and mortality	Chart review	Single-covariate analysis Multi-covariate analysis Analyses were performed using Comprehensive Meta-Analysis Software v.3	IV1: 1.64-5.10 ES2.88 CI: 95% IV2: 1.05-1.13 CI: 95% DV: 25%, CI 95%, (22-27%)	LOE: I - large sample size - Review of studies done prior to 2010. -prospective and retrospective analysis of studies done over 8 yrs Application: heterogenous patients demonstrating high correlation

ABX: antibiotics, **CF**: correctional facility, **C-SS**: cross-sectional study, **CS**: control study, **DV**: dependent variable, **EC**: exclusion criteria, **ED**: emergency department, **HCP**: healthcare provider, **I&D**: Incision and drainage, **IC**: inclusion criteria, **IEAT**: inappropriate empirical antibiotic treatment, **INPT**: inpatient treatment, **IV**: independent variable, **LOE**: level of evidence, **MDRO**: multidrug resistant organism, **MRSA**: Methicillin resistant staphylococcus aureus, **n**: sample size/people **N**: sample size/studies, **NI**: not identified in the study, **Obs**: observation, **OTPT**: outpatient treatment, **QIP**: quality improvement project, **RCT**: randomized control trial, **S**: setting, **SR**: systematic review, **SSTI**: skin and soft tissue infections, **TX**: treatment, **TXF**: treatment failure, **US**: United States, **$**: cost in US dollars, ↑: increase, ↓: decrease

Country: Israel								between MDROs and IEAT.
Citation	Theory/conceptual framework	Study 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
Drobniewski, F. (2015). Systematic review, meta-analysis and economic modelling of molecular diagnostic tests for antibiotic resistance in tuberculosis. Funding: The National Institute for Health Research Health Technology Assessment programme Conflicts/bias: none	Levels of prevention model	Systematic review Purpose: determine the efficacy of rapid molecular tests for drug resistance to determine if their accuracy would impact clinical practice	N: 6 n: NI IC: >18 yrs old, presence of MDRO infection EC: infection w/ no MDRO	IV1: molecular testing for ABX resistance IV2: treatment time delay effects on outcome DV: cost effectiveness r/t early identification of ABX resistance	Total cost of TX Quality-adjusted life-years	Probabilistic sensitivity analysis of 4 different tests	IV1: specificity of tests was 99.6%, 98.2%, 99.7%, & 98.4%. IV2: QALY was ↓ 3.5%	LOE: I -large sample size -analyzes tests with high reliability and specificity Application: initial testing decreases delays in treatment and improves outcomes

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Country: United Kingdom								
Citation	Theory/conceptual framework	Study 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
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: US	Levels of prevention model	Retrospective cohort study. Purpose: Assess the treatment of the SSTI based on a tool which grades the severity of the infection.	N= 200 S: community hospital in Brooklyn, NYC IC: patients with SSTI, >18 yrs old EC: those admitted w/ cellulitis r/t other disease processes, <18 yrs old	IV1: SSTI w/ varying degree of severity IV2: ability to recognize SSTI early DV: levels of treatment	IV1: CREST scoring based on tool IV2: SEWS Scoring (have Class I least-Class IV most severe) DV: measured based on route of antimicrobial given	ANOVA, Fischer's Exact test P<0.05	IV1: P= <0.05 IV2: P= <0.05 DV: compares overtreatment w/ undertreatment, P=<0.05	LOE: III Can utilize CREST tool in clinical practice at low cost Application: - established tools providers can ensure adequate TX is selected.
Citation	Theory/conceptual framework	Study Design/ Method	Sample/setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/Results	Level/Quality of Evidence; Decision for practice/ application to

ABX: antibiotics, **CF**: correctional facility, **C-SS**: cross-sectional study, **CS**: control study, **DV**: dependent variable, **EC**: exclusion criteria, **ED**: emergency department, **HCP**: healthcare provider, **I&D**: Incision and drainage, **IC**: inclusion criteria, **IEAT**: inappropriate empirical antibiotic treatment, **INPT**: inpatient treatment, **IV**: independent variable, **LOE**: level of evidence, **MDRO**: multidrug resistant organism, **MRSA**: Methicillin resistant staphylococcus aureus, **n**: sample size/people **N**: sample size/studies, **NI**: not identified in the study, **Obs**: observation, **OTPT**: outpatient treatment, **QIP**: quality improvement project, **RCT**: randomized control trial, **S**: setting, **SR**: systematic review, **SSTI**: skin and soft tissue infections, **TX**: treatment, **TXF**: treatment failure, **US**: United States, **$**: cost in US dollars, ↑: increase, ↓: decrease

								practice
Hassan, L. (2015) Accounting for Psychotropic Medication Changes in Prisons: Patient and Doctor Perspectives. Funding: Department of health Conflict/bias: undertaken as part of a work program offered by the Offender Health Research Network Country: United Kingdom	Grounded Theory	Observational, interview Purpose: To validate importance for continuity and equivalence of care for prisoners upon being detained. Utilized discursive approach, rooted in social constructionism	n=17 S: four prisons in England IC: >18 yrs old, incarcerated individuals EC: juvenile inmates	IV1: patient perspective IV2: HCP perspective DV: use of psychotropic medications	IV1/2: Interviews of each participant utilizing Foucauldian disclosure analysis. IV1/2: Interviews were transcribed, checked against audio recording.	Nvivo version 8	IV1: 4 common themes amongst subjects IV2: shared views regarding barriers that are present DV: correlated hx of psych diagnosis	LOE: IV -small number of participants -intensive analysis of interviews Application: demonstrates difficulty of pts receiving meds while incarcerated
Citation	Theory/conceptual framework	Study 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
Kamath, J. (2013). Algorithm-	Roy's Adaptation Model	Open-Label Trial, RCT	n=40, but only 29 completed	IV: Bipolar Disorder Symptom Scale	IV1: Bipolar Disorder Symptom Scale	Paired t-tests	IV1: p <.001	LOE: II

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Driven Pharmacological Management of Bipolar Disorder in Connecticut Prisons. Funding: National Institute of Mental Health Conflict/bias: none Country: US		Purpose: To establish whether evidence-based algorithms can aid in reducing polypharmacy	S: Connecticut prisons IC: >18 yrs old, incarcerated adults EC: hx of schizophrenia, hx of brain injury/head trauma	IV2: Global clinical status IV3: Comorbid symptomatology IV4: QoL DV: reduction of polypharmacy	(BDSS) IV1: Brief Psychiatric Rating Scale (BPRS) IV2: Global Assessment of Functioning scale (GAF) IV3: Short Form 36 Health Survey (SF-36) IV2: Clinical Global Impression (CGI)	Algorithm sub-analysis	IV2: p <.001 IV3: p <.002 IV4: p=1.88	Delineates importance of medication algorithm to help decrease variation in clinical practices and reduce costs. Application: supports adaptation of algorithms by correctional facilities through effectively identified barriers for the incarcerated population
Citation	Theory/conceptual framework	Study 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
Kamath, R.S. (2018). Guidelines vs Actual Management of Skin and Soft	Multifactorial causation theory	Retrospective analysis Purpose:	n= 240 S: Michael E. Debakey Veterans Affairs	IV1: baseline characteristics of SSTI used to decide TX IV2: clinical	Chart analysis	Stata 12 X^2 test Fisher's exact test	IV1: p < .001 IV2: p= .033	LOE: III Though setting is not correctional facility,

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Tissue Infections in the Emergency Department. Funding: none Conflict/bias: none Country: US		establish what percent of patients are being treated according to guidelines	Medical Center in Houston IC: >18 yrs old, dx of SSTI EC: 26 pt's due to alternate principal dx, to ED for f/u visit	findings Used to decide TX IV3: OTPT IV4: INPT DV: established guidelines DV2: HCP decision to of tx		Univariate logistic regression Multivariate logistic regression Hosmer-Lemeshow test	IV3: 39.7% IV4: 60.3%	population included is only adults dx w SSTI. Application: Highlight the low percentage of SSTI being TX w/ proper meds and setting according to guidelines.
Citation	Theory/conceptual framework	Study 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
Labreche, M. (2013). Treatment failure and costs in patients with methicillin-resistant Staphylococcus aureus (MRSA) skin and soft tissue infections: A South Texas	Multifactorial causation theory	Observational cohort study Purpose: Measure the prevalence of TXF and additional $ in pts w/ SSTI	N: 13 clinics n= 265 S: South Texas region IC: > 18 yrs old, dx w/ SSTI	IV1: incidence of TXF IV2: $ associated w/ TXF DV: Additional costs of TXF r/t rates of TXF for	Medical chart reviews Follow-up forms	JMP 9.0 software Chi-square test Fisher's Exact test t-test	IV1: p >0.05 IV2: ~$2,000/pt DV: ↑ costs	LOE: II -Serves to highlight the need for adequate stratification of infections at baseline Application:

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Ambulatory Research Network (STARNet) study. Funding: Pfizer and the U.S. National Institutes of Health Conflicts/bias: clinics were compensated $50 for each pt they enrolled Country: US			EC: pregnancy, incarceration, impaired decision-making capacity	OTPT		Wilcoxon Rank-Sum test		Will serve to demonstrate the links between inadequate selection of antibiotics as well as support the financial implications of TXF as a result of IEAT with an emphasis on MRSA infections
=Citation	Theory/Conceptual framework	Study 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	Multifactorial causation theory	Observational cross-sectional study. Purpose: Understand the factors which may influence	n= 400 S: US, United Kingdom (50 MD from ED, 50 MD from ID, 50 NP) IC: >18 yrs old	IV1: SSTI w/ varying degree of severity IV2: different	IV1: evaluation of presenting criteria determines level of infection IV2: demographic	Multinomial Model CI: 95% Mixed effects Model	IV1: p= 0.02 IV2: age < 75 had decreased	LOE: Level II Convenience sample was utilized and may not represent general population,

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skin and skin structure infections: Results of a discrete choice experiment. Funding: The Medicines Company. Conflicts/Bias: The author works for the Medicines Company. Country: United Kingdom		the setting in which SSTI should be treated. Online survey, 3 part	EC: < 18 yrs old,	age groups DV: OTPT tx vs INPT tx	criteria DV: included in information gathering		probability of outpt tx (0.28-0.61)	creating slight bias, and could affect interpretation of results Application: Identifying key factors that affect TX. Highlights importance of severity stratification in selecting TX.
Citation	Theory/conceptual framework	Study 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
Mullen & O'keefe. (2015). Management of skin and soft tissue infections in a county correctional facility: A quality	Pender's Health Promotion Model	Quality improvement project Purpose: examine current management	n= 132 S: DCDC IC: inmates, prescribed multiple ABX for suspected MRSA	IV: incidence of SSTI DV: TX of SSTI utilizing new tool/assessment	Baseline needs assessment 60-day outcome interview	Chart review	-improving screening protocol helped identify infection sooner -making data collection simple increased	LOE: IV - limited to one correctional facility - ample subject inclusion Application:

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improvement project. Funding: none Conflicts/bias: none Country: US		within DCDC compared to current best clinical practices and guidelines	EC: diagnosed w/ SSTI prior to incarceration	process vs guidelines			identification -increasing hygiene was done through DVD showings within housing units -implementing documentation templates can increase early identification	combining data from each facility and comparing with current guidelines can help develop protocol for each organization
Citation	Theory/conceptual framework	Study 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
Talan, D.A. (2014). Factors associated with decision to hospitalize emergency department patients with skin and soft tissue infections. Funding: Centers for	Multifactorial causation theory	Retrospective cohort study Purpose: Identify any factors that may determine the need for a pt w/ SSTI to be hospitalized	n= 619 S: 12 ED in the US IC: > 18 yrs old, diagnosis of SSTI EC: < 18 yrs old	IV1: A, prior infection IV2: hx of previous OTPT IV3: TXF DV1: Admitted with SSTI or DV2: discharged	Physicians filled out surveys asking them for the reasons for admission/clinical characteristics of infection at the time of presentation	Statpages, 2-way contingency table analysis Chi-Square binary recursive partitioning CI: 95%	IV1: CI 2.31-5.22 ES: 3.47 IV2: NI IV3: CI 1.38-3.72 ES: 1.76	LOE: III -addresses important variables -variable sample size Quality of evidence: safe method Application:

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Disease Control Conflicts/bias: none Country: US				with SSTI				provides reasons for providers to establish IP vs OP tx

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Appendix F

Table 2

Synthesis Table

Study Characteristics	Carrara	Drobniewski	Hashem	Hassan	Kamath, J.	Kamath, R.S.	Labreche	Lane	Mullen	Talan
Year	2017	2015	2016	2016	2013	2018	2013	2016	2015	2014
LOE	I	I	III	IV	II	III	II	II	IV	III
Conflict/bias	None	None	None	Yes	None	None	Yes	Yes	None	None
Location	Israel	UK	US	UK	US	US	US	UK	US	US
Design	SR	SR	Retro CS	Obs Int	RCT	Retro analysis	Obs study	Obs C-SS	QIP	Retro CS
N	73,595	56	200	17	40	240	265	400	132	619
Setting	Other	Other	community hospital	CF	CF	Large hospital	community hospital	Large hospital	CF	ED
IV's										
Abx Stewardship program	x						x		x	
Severity tool			x							
algorithm		x			X					
Follow guidelines				x		x		x		x
Outcomes										
IEAT	x		x			x			x	
TXF	x			x		x	x	x	x	x
INPT			x		x	x	x	x		x
OTPT			x		x	x	x	x		x
I&D	x					x				

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Non-compliance			x	x	x					
Cost		↑↑			x		↑↑		↑↑	↑↑
TX time		↑					↑		↑	↑
Mortality	x	x								

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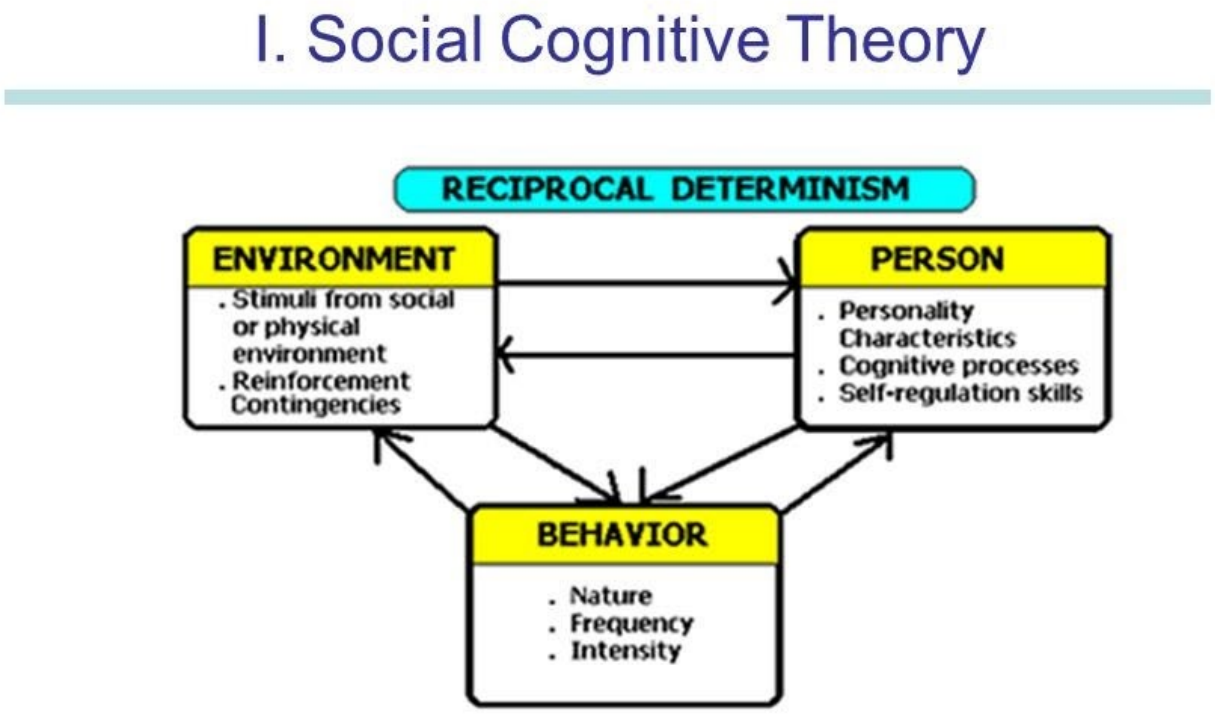
Appendix G



Social Cognitive Theory

(Bandura, 1986)

Appendix H

PDSA Quality Improvement Model