Screening for Polypharmacy in the Elderly Population

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Abstract

Background. The population of 65 years and older has increased exposure to polypharmacy, with data showing up to 42% taking five or more medications. Polypharmacy increases the frequency of potentially inappropriate medications prescribed which are associated with adverse drug events and higher healthcare costs. The Screening Tool of Older Persons' Prescriptions and Screening to Alert to Right Treatment criteria have demonstrated effectiveness in identifying potentially inappropriate medications and preventing adverse drug events.
Local Problem. A large, academic medical center neurology practice site used a standard medication reconciliation for its patients over the age of 65. They did not have an enhanced medication screening process for that population.
Interventions. The quality improvement project used the Screening Tool of Older Persons' Prescriptions and Screening to Alert to Right Treatment criteria to augment the medication reconciliation process on the general neurology inpatient service. The transtheoretical model was used to guide interventions based on the stages of change to produce this change in behavior towards enhanced medication screening. During the seven-week implementation, patients over age 65 admitted to the service were screened by providers using the tool's criteria. A clinical pharmacist consultation was to be initiated for positive findings.
Results. During the implementation, 29 of the 73 patients admitted to the service were eligible for screening. The providers completed nine screenings for an overall compliance of 31%, falling below the goal of 80%. Five (55%) of the patients screened positive, resulting in three consults to the clinical pharmacist for an overall consult compliance of 60%. Two of the positive screenings resulted in medication changes for the patients. Following the implementation, the providers evaluated the Screening Tool of Older Persons' Prescriptions and Screening to Alert to Right Treatment criteria using the System Usability Scale with a final average score of 86.25 out of 100, indicating the process was highly usable.
Conclusions. Despite the low compliance with screening, the presence of a potentially inappropriate medication in 55% of the patients screened suggests this population is at a high risk for polypharmacy exposure and enhanced medication reconciliation is warranted. A behavior change was not fully established among the physician team as they remained in the contemplative stage of change while the nurse practitioner on the team progressed to the action stage. The results from the System Usability Scale survey indicated the criteria were easy to use and are a viable option for sustained integration into the medication reconciliation process. The loss of the provider champion greatly impacted the ability of the project lead to achieve buy-in with the neurology team. The results of this project are limited based on the small sample size and a complete turnover of resident physicians during the implementation. A focus on achieving provider buy-in is necessary to achieve sustainability. Future work should be aimed at the development of an automated version of the criteria, integrating the process into established workflow, and the evaluation of the impact of medication screening on patient outcomes such as medication costs and adverse drug events.

Screening for Polypharmacy in the Elderly Population

Prescription medications are a powerful tool for health promotion and the fight against disease. In the United States, the use of prescription drugs has steadily increased over the last several decades, particularly among the elderly population (National Center for Health Statistics, 2017). This rise in the number of prescriptions has resulted in a growing health concern referred to as polypharmacy, commonly defined as the use of five or more medications concurrently. In 2014, 42% of people over age 65 were taking more than five medications, compared to only 14% in 1994 (National Center for Health Statistics, 2017). This marked increase in medication use among the elderly is likely due to higher rates of chronic disease, multiple comorbidities, and physiological changes associated with aging and, therefore, may be completely appropriate (Barclay, Frassetto, Robb, & Mandel, 2018). More than 21% of those over age 65 reported being in "fair" or "poor" health compared to only 10% for all other ages (National Center for Health Statistics, 2017). The decreased health status of the elderly population could logically result in an increase in medication use. This increase, however, also increases the possibility of inappropriate medications or medication combinations.

According to the Agency for Healthcare Research and Quality (AHRQ), the rates of adverse drug events (ADE) have steadily increased among patients in the United States and account for more than 1.6 million hospital stays per year (Weiss, Freeman, Heslin, & Barrett, 2018). These ADEs are associated with increased healthcare costs (+$1851.44 per stay, $p < 0.001$), longer hospital stays (+1.89 days, $p < 0.001$), and increased risk of in-hospital death (1.27 mortality odds, $p < 0.001$) (Poudel, Acharya, Ghimire, Dhital, & Bharati, 2017; Weiss et al., 2018). The elderly population has experienced higher percentages of hospital admissions related to an ADE as compared to younger age groups (see Table 1) (Poudel et al., 2017).

However, this increase in polypharmacy also increases the frequency of potentially inappropriate medications (PIM) and ADEs (Barclay et al., 2018; Poudel et al., 2017). While having too many medications is frequently the concern for healthcare providers and patients, not having the correct medications can be equally harmful. Up to 74% of patients over age 65 have a potential prescribing omission (PPO) (Hill-Taylor et al., 2013). In other words, these patients were missing a medication that should have been prescribed based on their condition. PIMs and PPOs are more likely to occur in patients exposed to polypharmacy due to the increased number of medications, and therefore the increased number of medication interactions. Furthermore, as previously discussed, polypharmacy is more prevalent in the elderly population with more disease burden, thereby increasing the potential for prescribing omissions based on the recommendations for multiple chronic disease states.

PIMs and PPOs both increase the risk for ADEs among elderly patients. At the organizational level of the practice site for this project, there is a concern over the lack of standardized polypharmacy screening for patients over age 65. Several tools have been developed to address this issue including the Screening Tool of Older Persons' Prescriptions (STOPP) (see Appendix B) and Screening to Alert to Right Treatment (START) (see Appendix C) criteria (O'Mahony et al., 2015). The STOPP/START criteria were originally developed in Europe in 2008 and then updated in 2015 as a method to alert providers to potentially inappropriate medications and prevent ADEs (O'Mahony et al., 2015). In a randomized-controlled trial, application of the STOPP/START criteria resulted in a significant decrease in the rate of ADE's (p=0.001) compared to normal treatment without screening (O'Connor et al., 2016). Additionally, a retrospective review showed that up to 13.3% of ADEs could have been prevented with STOPP criteria screening (Vinluan, Aldaz, Dominguez, & Ha, 2017). The

STOPP/START identifies more PIMs per patient (4.3 versus 1.9, $p < 0.001$) compared to the well-known Beers Criteria, and the PIMs identified are more likely to be associated with ADEs (odds ratio 1.847 versus 1.276, $p < 0.001$) (Boland, Guignard, Dalleur, & Lang, 2016; Hill-Taylor et al., 2013).

In a recent Italian study, researchers utilized the STOPP/START criteria to evaluate the predictors and prevalence of PIMs and PPOs in patients on discharge from the hospital (Bo et al., 2019). The multi-center study showed 54.4% of patients were exposed to a PIM and 44.5% to a PPO (Bo et al., 2019). In their analysis of predictors of inappropriate medications, the authors found that the patient's overall number of medications (i.e. polypharmacy exposure) was associated with increased PIMs and PPOs, while age and number of comorbidities were associated with increased PPOs (Bo et al., 2019). Furthermore, discharge from a unit specializing in geriatric care showed an inverse association with PPO and PIM prevalence (Bo et al., 2019). These results strongly support the use of the STOPP/START criteria as a means of reducing polypharmacy, and thereby reducing exposure to PIMs and PPOs.

The STOPP/START criteria were used for a Doctor of Nursing Practice (DNP) project to address organizational concerns related to polypharmacy at a large urban quaternary academic medical center. The purpose of this Quality Improvement DNP project was to implement and evaluate the usability of a screening tool to identify polypharmacy and initiate consultation with a Clinical Pharmacy Specialist to evaluate for PIMs and PPOs in patients over age 65 admitted to the General Neurology service. Additionally, the STOPP/START screening tool was assessed for general usability by the neurology providers. Based on the increased screening and pharmacy consultation, the desired long-term effect was a decrease in ADEs for Neurology patients.

Theoretical Framework

This DNP project employed the Transtheoretical Model (TTM) framework. The TTM was originally developed in the 1980's to describe the process of behavior change (Prochaska, Redding, & Evers, 2015). The TTM was designed to bring together all of the specific behavioral theories to provide one model that could be applied to behavior change in any population (Prochaska et al., 2015). The primary tenants of the TTM are the stages of change that describe a clear, step-wise progression of stages that an individual must go through to achieve a change in behavior (Prochaska et al., 2015). The stages of change include 1) precontemplation, 2) contemplation, 3) preparation, 4) action, and 5) maintenance. The individual must progress to the maintenance stage to achieve a true change in behavior, but the stages cannot be skipped and must be completed in order (Prochaska et al., 2015). Therefore, interventions must be tailored to the individual's current stage of change rather than focusing on the end-goal behavior. For instance, if an individual is in the precontemplation stage then they are not aware that a change is needed or have no intention of making a change. Interventions for this individual should be focused on education and awareness of the potential problem. Conversely, an individual in the action stage has already made a behavior change and interventions should be aimed at helping to remove barriers and enhance the new behavior. Interventions are only effective if they are tailored to the individual's current stage of change and aimed at assisting the individual towards reaching the next stage (Prochaska et al., 2015).

The TTM was used in this DNP project to guide the development of interventions based on the stages of change. The goal of the DNP project was to introduce a screening tool to the neurology providers, basically amounting to a change in behavior as they were expected to incorporate this tool into their daily practice. Interventions aimed at developing this new behavior were tailored to the current stage of change of the providers. Therefore, part of the

initial implementation included an assessment of the providers to determine their stage of change. Initial interventions were aimed at educating the providers on the proposed solution and achieving buy-in for the implementation. As the providers moved into the preparation and action stages, interventions were shifted to assisting them in performing the desired behavior and removing barriers. Finally, the implementation of any new process, to be sustainable, must include a maintenance plan. As the screening was adopted by the providers and they shifted into the maintenance stage, the interventions shifted to assist them in maintaining the new behavior.

Literature Review

The importance of screening for polypharmacy with an emphasis on identifying inappropriate medications and preventing ADEs was the focus of the evidence in this literature review. The review began with the evidence comparing various methods of screening for polypharmacy and their ability to identify clinically significant medication changes. The discussion then narrowed to the evidence specifically evaluating the implementation of the STOPP/START screening tool. Finally, the review concluded with the current evidence regarding the effect of the STOPP/START tool on ADEs and other clinical outcomes.

Boland, Guignard, Dalleur, and Lang (2016) conducted a retrospective review of twenty randomly selected patients admitted to an acute geriatric medicine unit. Each patient was evaluated with both the STOPP/START and Beers Criteria for comparison. The authors concluded that version two of the STOPP/START tool was the most effective at identifying clinically significant medication changes with an average reduction in medications per patient (4.3) three times that of any other tool (1.5, $p<0.001$). The strength of this evidence is the demonstration of the clinical benefit of one polypharmacy screening tool over another as the STOPP/START tool was able to identify more “clinically significant” medication changes (23)

compared to the Beers Criteria (14). However, the small sample size (20) limits the external validity. Additionally, the study was conducted in Europe where the STOPP/START tool was developed. The Beers criteria was developed in North America and prescribing trends in Europe may have naturally favored the STOPP/START tool, decreasing the internal validity of the results. As a retrospective analysis, there is a risk of selection bias in the patients that were reviewed although this risk was decreased through random selection.

Narrowing the discussion to the STOPP/START tool, Hill-Taylor et al. (2013) conducted a systematic review of thirteen studies involving the application of the criteria. The authors found that the STOPP/START criteria have been effectively implemented to identify PIMs in both acute care and out-patient environments in Europe, Asia, and North America. Particularly important to this DNP project, the authors identified the most common barriers documented in implementing the criteria (see Appendix A). Additionally, the authors provided the average time for application of the criteria at three to four minutes. A majority of the patients in the studies were in Ireland and there is concern over variability in the application of the criteria between the studies, which may limit external validity. However, the thirteen studies included more than 300,000 patients resulting in a large, diverse sample size including 111 patients from the United States. Additionally, a majority of the studies were assessed to have low risk of bias which decreases the threat to internal validity.

In order to determine the effect of the tool on clinical outcomes, Vinluan et al. (2017) conducted a retrospective review of 139 elderly patients admitted to three medical centers with a documented ADE to determine if the STOPP/START criteria could have prevented the event. The authors concluded that 13.3% of the ADEs could have been prevented and also found that the criteria could be implemented in only one to two minutes. The strength of this evidence is

that it showed the effect of the criteria at three different time points during the patient's hospitalization (Appendix A). Additionally, by measuring the time required to implement the tool the authors provide guidance for the development of future application techniques. The sample size limits the external validity and a single pharmacist was used for all evaluations, increasing the risk of bias.

O'Connor et al. (2016) took the clinical effect of the STOPP/START criteria one step further by conducting a prospective, randomized-controlled trial (RCT) to determine the effect of the screening on ADEs, length of stay, and medication costs for 372 elderly in-patients. The authors found that application of the STOPP/START criteria within 48 hours of admission resulted in a significant decrease in the rate of ADEs (11.7% study; 21% control; $p < 0.001$) and medication costs (€73.16 study; €90.62 control; $p = 0.001$). The study intervention provides a blue-print for the implementation of the STOPP/START criteria in acute care and demonstrates statistically and clinically significant effects on patient outcomes. This prospective, randomized design improves external validity of the findings despite being a single-center trial. However, the attending physician was unable to be blinded to the patient's study group due to the requirement to accept or reject the recommendations of the tool. This knowledge could create treatment bias.

The STOPP/START criteria are an effective method for polypharmacy screening. A large amount of the research is dedicated to comparing the STOPP/START and the Beers Criteria, although recently there has been a shift towards clinical outcomes. The first two studies focused on the ability of the criteria to identify PIMs while the latter two were aimed at identifying the effect on patient outcomes, particularly ADEs. While a majority of the researchers used retrospective analysis, O'Connor's team showed that the STOPP/START criteria can be used prospectively with a significant effect on clinical outcomes by reducing ADEs and medication

costs (2016). The criteria can be implemented in only a few minutes and the primary barriers to implementation have been identified including the time to learn the tool, having to use several information sources to complete the tool, and using the tool during transition periods (Hill-Taylor et al., 2013). Although the STOPP/START was developed in Europe and a majority of the evidence is European, Hill-Taylor's review (2013) and Vinluan's analysis (2017) show that the criteria are effective in the United States. The evidence overwhelmingly supports the use of the STOPP/START criteria as a screening for polypharmacy because it has superior performance than the Beers Criteria and demonstrated improvement in patient outcomes.

Implementation Plan

This quality improvement project was focused on the addition of a polypharmacy screening to the admission medication reconciliation process and took place on the general neurology service at a large urban quaternary academic medical center. The intervention was the application of the STOPP/START criteria by the general neurology service providers (n = 15). The estimated sample size was based on a rotation of five providers every two weeks for a six-week implementation. Inclusion criteria for the provider sample was resident physicians, advanced practice nurses, and physician assistants providing care for patients admitted to the general neurology service. Inclusion criteria for the patient population were age 65 years or more, admission or transfer to the general neurology service, and assignment to one of the neuro units, not including the intensive care unit. The projected patient sample size was based on an average daily admission rate of two to eight patients over six weeks for a range of 84 to 336 patients.

The implementation followed an eleven-week timeline (see Figure 1). During the first week, the providers were educated on the project plan and intervention (see Appendix E). The

education was provided by the project coordinator (PC) in the form of an in-service presentation. The PC conducted a demonstration of the application of the STOPP/START criteria, the consult ordering process, and the collection of the completed screenings. The intervention was then implemented for a trial period during week 2. As part of the medication reconciliation process, the providers used the STOPP/START criteria to screen all eligible patients for polypharmacy within 48 hours of admission. If the criteria resulted in a positive finding, the providers initiated a consult to the clinical pharmacist. The pharmacist recorded the number of consults received and whether a recommendation was made. The results of the criteria screening were recorded on a result form with no patient identification (Appendix J) and were placed in a sealed collection box in the Neurology staff room. The forms were destroyed after being reviewed by the PC. During this week, the PC performed daily audits for compliance and addressed any immediate barriers identified by the providers.

The six-week implementation period took place from week three to week eight. During this period, the PC performed bi-weekly collections of the completed criteria. Following the implementation, there was a two-week period to evaluate the usability of the criteria by distributing surveys to the providers. The final week of the implementation plan was used for data analysis.

Data collection was conducted with the STOPP/START criteria and the System Usability Scale (SUS). The STOPP/START criteria are separated into sections based on organ systems and provide guidance for the identification of PIMs and PPOs (see Appendix B). The results of the screening were collected in a de-identified, dichotomous flowsheet of either positive or negative results. The number of consults generated by the providers was recorded by the clinical pharmacist. Additionally, the number of eligible patients admitted to the service was collected for

comparison to the number of screenings conducted. Following the implementation, the criteria were assessed using the SUS in the form of a survey for the providers (Appendix F). The SUS is a valid, reliable tool that has become the standard for assessing usability across a wide variety of systems (Lewis & Sauro, 2018; Brooke, 2013). In addition to the SUS, the providers had the opportunity to answer several open-ended questions regarding the use of the criteria (Appendix G).

Data analysis was performed using Microsoft Excel. Descriptive statistics were used for weekly compliance (*n,* %) and overall compliance following the six-week implementation (*n,* %). The analysis included compliance for both the initial screening and the initiation of a consult. The number of patients with positive findings was compared to the number of consults received by the pharmacist. The scores for the SUS were calculated using the standard process outlined by the tool's authors to determine the overall usability of the criteria (Appendix H). Descriptive statistics was also used for the SUS scores.

To protect human subjects, no protected health information was collected during this project. The weekly and overall compliance was kept using a de-identified list with simple numbers for compliant versus non-compliant screenings. The clinical pharmacist reported only the number of consults received and whether a recommendation was made without including any patient information or details of the recommendation. The STOPP/START criteria and the SUS did not require permission for use in this project. Additionally, the project proposal was submitted to the University of Maryland, Baltimore Institutional Review Board (IRB) for a non-human subject's research determination prior to implementation.

Following the data analysis, the findings from the project were disseminated to the practice site to assist in developing a sustainment plan. Based on the number of pharmacy

consults generated, the site will be able to identify if there is a need for additional pharmacy support on the general neurology service. These data provide a basis for the continued implementation of polypharmacy screening and adoption of the criteria in other areas of the facility. Based on the findings of this project, future evaluation should be conducted to determine if the STOPP/START criteria are able to reduce the incidence of ADEs at the practice site, thereby decreasing healthcare costs. These cost savings could be used to develop or purchase an automated version of the STOPP/START criteria, increasing the sustainability of the project by including the screening in the routine documentation systems rather than requiring an additional process.

Results

The DNP project resulted in a process change to the medication reconciliation process for the general neurology service. The STOPP/START criteria were integrated into the process in addition to providing a trigger for pharmacy consultation for assistance in assessing medication appropriateness. The results of the STOPP/START screenings are summarized in Table 2 and Figure 2. Of the 29 eligible patients, 9 screenings were completed for an overall screening compliance of 31%. There were 5 patients with positive findings (55.5%) out of the 9 screened, resulting in 3 consults to pharmacy for an overall consult compliance of 60%. None of the pharmacy consults resulted in a recommendation to alter treatment from the clinical pharmacist. Two of the positive findings resulted in medication changes made by the General Neurology providers. Of the five patients with positive findings, three (33%) showed a PIM, one showed a PPO (11%), and one (11%) showed both a PIM and PPO. After the implementation, three providers completed the SUS and follow-up survey. The overall usability score of the criteria was 86.25.

The project experienced several unanticipated barriers and benefits. The delegation of the screening by the residents to the medical students was an unanticipated barrier to the project as they were not included in the initial education plans. However, the medical students reported an unintended benefit of the screening by utilizing the criteria during patient rounding for discussions of medication appropriateness. Additionally, the low volume of patients during the first several weeks of the implementation resulted in the inclusion of transfer patients starting in week 3. Following the implementation, the low response rate and difficulty in obtaining follow-up surveys was an additional unanticipated barrier

Discussion

The STOPP/START criteria were clearly effective in identifying inappropriate medication exposure in the target population. More than half of the patients screened (55%) showed either a PIM or a PPO, which is similar to the incidence ranges (21% – 79%) reported in a systematic review and the findings of a recent Italian study (54%) (Hill-Taylor et al., 2013; Bo et al., 2019). Furthermore, two of the five patients with positive findings experienced a major medication change based on the finding. These results demonstrate that this patient population is at a high risk for polypharmacy and that the STOPP/START criteria are effective for identifying potentially inappropriate medications.

Despite these findings, the project implementation failed to meet the compliance goals (80%) for both screening and consultation. There were several contributing factors to the poor compliance. The loss of the provider champion just before the project initiation made it extremely difficult to establish buy-in from the physicians. The project was developed in conjunction with this specific provider and he was highly invested in assisting with promoting the change in practice among the resident physicians. This champion left the service in the weeks

just before implementation, forcing the project lead to attempt to find a replacement, which was unsuccessful. Without the support of the physician providers, the screening failed to gain traction as evidenced by the fact that all the completed screenings were done by either a nurse practitioner or a medical student. Zero screenings were completed by a physician despite them making up the bulk of the neurology team. In relation to the theoretical framework of the project, the physicians never progressed past the contemplation phase of behavior change. Based on conversations with the team, some identified that there was a problem with polypharmacy, but most felt that their current practice was sufficient to identify problematic medications. The screening results support otherwise. The nurse practitioners and medical students, conversely, expressed that they were highly concerned about polypharmacy and identified the need for a change in practice. These individuals advanced to the action phase of the transtheoretical model and were the primary change agents for the process. However, without the resident participation, the compliance numbers remained low.

The next factor impacting compliance only further decreased physician buy-in as the entire resident team changed mid-way through the project. Any support that had been gained was lost and the education started over. At the same time, the decision was made to include transfer patients in the screening because the admission numbers of patients over 65 were low. Prior to this change, the screening compliance was 57% and the consult compliance was 100%, although there were only 7 eligible patients over the first three weeks. Following the change, there were 22 eligible patients over the final four weeks but there was a screening compliance of 22% and a consult compliance of 33%. The combination of the new residents and a sudden increase in the number of eligible patients resulted in an unexpected drop in compliance.

Based on the poor compliance, the SUS results were anticipated to be low as the team did not use the criteria regularly. However, the SUS score following the implementation was extremely high (86.25), indicating that the process itself was exceptionally usable. For reference, a score above 80 puts the process in the top 10% of scores and is the point where users are likely to recommend the process to a colleague (Lewis & Sauro, 2018). These sentiments were corroborated by discussions with the providers in which they described the criteria as highly beneficial and intuitive. Furthermore, the medical students reported an unintended benefit of the screening by utilizing the criteria during patient rounding for discussions of medication appropriateness.

The strengths of the project were an evidence-based intervention with a large amount of literature support related to the risks of polypharmacy and an established tool that has been shown to be effective in multiple populations. Additionally, the results of the screenings show that enhanced medication reconciliation is warranted in this specific elderly population with more than half of the patients being exposed to a potentially inappropriate medication. Furthermore, the project was an augmentation to an existing medication reconciliation process and required very little alteration in work flow. Finally, the project encouraged multidisciplinary collaboration by providing a trigger for clinical pharmacy consultation.

The project also experienced several limitations. The sample size was extremely low with 9 patients being screened. A total of 73 patients were admitted to the service with only 29 (38%) meeting inclusion criteria (over age 65), and 22 of those 29 (76%) came after the expansion to include transfer patients. While this expansion successfully increased the number of eligible patients, it also potentially compromised the results since the transfer patients may have already been screened by a pharmacist on their previous unit. This bias is particularly likely in patients

that were transferred from the neuro-ICU since the pharmacist assigned to that unit was also the clinical site representative and pharmacy champion for the project. Furthermore, the process of screening and pharmacy consultation was tailored specifically to this practice site, thereby limiting the generalizability of the work. However, the general concept of utilizing the screening as a trigger for a clinical pharmacist consult could easily be applied to other areas. Finally, since the tool and tracking mechanism were paper-based, compliance was more difficult to track and required additional efforts by the providers as opposed to a digital method. The tool and trackers were kept as simple as possible to minimize the additional effort required, but this aspect of the project design likely contributed to poor compliance.

Conclusion

The results of this project add to the body of evidence in support of medication screening for patients over age 65. Furthermore, the project has demonstrated that even patients under the expert care of a specialized service at a large, academic medical center are still at risk for inappropriate medications. Additionally, the SUS results show that the STOPP/START criteria are a viable option for integration into enhanced medication reconciliation processes. To achieve sustainability, the priority must be given to obtaining physician buy-in and integrating the tool into the standard resident orientation. The criteria should be further integrated into routine processes such as adding verification of the screening to the rounding checklist or documenting the screening in the medical record. Sustainability would be greatly enhanced through an automated version of the criteria that would eliminate the paper-based system employed by this project. Such a program is currently under development but would require a financial commitment or separate development of an algorithm to incorporate into the existing medical record. While this project was specifically designed for the neurology service at this location, the

model of using a medication screening as a trigger for pharmacy consultation could easily be adopted in other areas as a method to decrease polypharmacy and increase interdisciplinary collaboration.

Future projects should be aimed at improving sustainability and evaluating the impact of the screening on patient outcomes such as the number of medications per patient, medication costs, and incidence of adverse drug events. Additionally, providers should be educated on the risks associated with polypharmacy and the utility of screening tools to assist in reconciling complex medication regimens. Future practice in the care of elderly patients must include some form of advanced medication screening. As the population of 65 and over continues to grow, processes that can provide an efficient means of reducing polypharmacy will become even more important.

References

Barclay, K., Frassetto, A., Robb, J., & Mandel, E.D. (2018). Polypharmacy in the elderly: How to reduce adverse drug events. *Clinician Reviews, 28*(2), 38-45.

Bo, M., Giello, M., Brunetti, E., Boietti, E., Sappa, M., Falcone, Y., … & Cappa, G. (2019). Prevalence and predictors of inappropriate prescribing according to the Screening Tool of Older People's Prescriptions and Screeing Tool to Alert to Right Treatment version 2 criteria in older patients discharged from geriatric and internal medicine wards: A prospective oversvational study. *Geriatrics & Gerontology International, 19*(1), 5-11.

Boland, B., Guignard, B., Dalleur, O., & Lang, P.-O. (2016). Application of STOPP/START and Beers Criteria: Compared analysis on identification and relevance of potentially inappropriate prescriptions. *European Geriatric Medicine*, *7*(5), 416–423. https://doi.org/10.1016/J.EURGER.2016.03.010

Brooke, J. (2013). SUS: A retrospective. *Journal of Usability Studies, 8*(2), 29-40.

Hill-Taylor, B., Sketris, I., Hayden, J., Byrne, S., O'Sullivan, D., & Christie, R. (2013). Application of the STOPP/START criteria: A systematic review of the prevalence of potentially inappropriate prescribing in older adults, and evidence of clinical, humanistic and economic impact. *Journal of Clinical Pharmacy and Therapeutics*, *38*(5), 360–372. https://doi.org/10.1111/jcpt.12059

Lewis, J. R., & Sauro, J. (2018). Item benchmarks for the System Usability Scale. *Journal of Usability Studies, 13*(3), 158-167.

National Center for Health Statistics. (2017). *Health, United States, 2016: With chartbook on long-term trends in health.* Hyattsville, MD: U.S. Government Printing Office. Retrieved from https://www.cdc.gov/nchs/data/hus/hus16.pdf

O'Connor, M. N., O'Sullivan, D., Gallagher, P. F., Eustace, J., Byrne, S., & O'Mahony, D. (2016). Prevention of hospital-acquired adverse drug reactions in older people using Screening Tool of Older Persons' Prescriptions and Screening Tool to Alert to Right Treatment criteria: A cluster randomized controlled trial. *Journal of the American Geriatrics Society*, *64*(8), 1558–1566. https://doi.org/10.1111/jgs.14312

O'Mahony, D., O'Sullivan, Byrne, S., O'Connor, M. N., Ryan, C., & Gallagher, P. (2015). STOPP/START criteria for potentially inappropropriate prescribing in older people: Version 2. *Age and Ageing, 44*(2), 213-218.

Poudel, D. R., Acharya, P., Ghimire, S., Dhital, R., & Bharati, R. (2017). Burden of hospitalizations related to adverse drug events in the USA: A retrospective analysis from large inpatient database. *Pharmacoepidemiology and Drug Safety*, *26*(6), 635–641. https://doi.org/10.1002/pds.4184

Prochaska, J. O., Redding, C. A., & Evers, K. E. (2015). The transtheoretical model and stages of change. In *Health behavior: Theory, research, and practice* (5th ed.) (pp. 125–148). San Francisco: Jossey-Bass. Retrieved from http://eds.a.ebscohost.com.proxy-hs.researchport.umd.edu/eds/detail/detail?vid=0&sid=812aa87e-55d8-46f1-b0f3-20b11ab3363d%40sessionmgr4007&bdata=JnNpdGU9ZWRzLWxpdmU%3D#AN=2015-35837-007&db=psyh

Sutherland, J. J., Daly, T. M., Liu, X., Goldstein, K., Johnston, J. A., & Ryan, T. P. (2015). Co-prescription trends in a large cohort of subjects predict substantial drug-drug interactions. *PloS One*, *10*(3), e0118991. https://doi.org/10.1371/journal.pone.0118991

Vinluan, C. M., Aldaz, M. G., Dominguez, N., & Ha, E. C. (2017). Identifying the prevalence of adverse drug events associated with potentially inappropriate medications using the

Screening Tool of Older Persons' Prescriptions criteria. *Journal of Pharmaceutical Health Services Research*, *8*(3), 187–192. https://doi.org/10.1111/jphs.12179

Weiss, A. J., Freeman, W. J., Heslin, K. C., & Barrett, M. L. (2018). *Adverse drug events in U.S. hospitals, 2010 versus 2014* (HCUP Statistical Brief #234). Rockville, MD: Agency for Healthcare Research and Quality. https://www.hcup-us.ahrq.gov/reports/statbriefs/sb234-Adverse-Drug-Events.pdf

Tables

Table 1

Incidence of ADEs Among Total Hospital Discharges by Age Group

Age group (years)	% (95% CI)
0-28	2.3 (2.12-2.50)
29-53	6.32 (6.11-6.55)
54-72	8.97 (8.67-9.28)
≥73	9.61 (9.26-9.92)

Note. ADE = adverse drug event; CI = confidence interval. Adapted from "Burden of hospitalizations related to adverse drug events in the USA: A retrospective analysis from large inpatient database." by D.R. Poudel, P. Acharya, S. Ghimire, R. Dhital, & R. Bharati, 2017, *Pharmacoepidemiology and Drug Safety*, *26*, p. 638. Copyright 2017 by John Wiley & Sons, Ltd.

Table 2

Results of STOPP/START Criteria Screening and Compliance

Week	Eligible Patients (*n*)	Patients Screened (*n*)	Patients with PIM or PPO (*n*)	Pharmacy Consults (*n*)	Screening Compliance (%)	Consult Compliance (%)
Run-in	4	2	2	2	50	100
1	1	1	0	0	100	N/A*
2	2	1	0	0	50	N/A*
3	10	2	1	0	20	0
4	7	1	1	1	14	100
5	2	0	0	0	0	N/A*
6	3	2	1	0	67	0
Total	**29**	**9**	**5**	**3**	**31**	**60**

Note. *There were no positive screenings during this week, so there was no requirement for a pharmacy consult. Either a PIM or a PPO finding equates to a positive screening. PIM = potentially inappropriate medication. PPO = potential prescription omission.

Figures

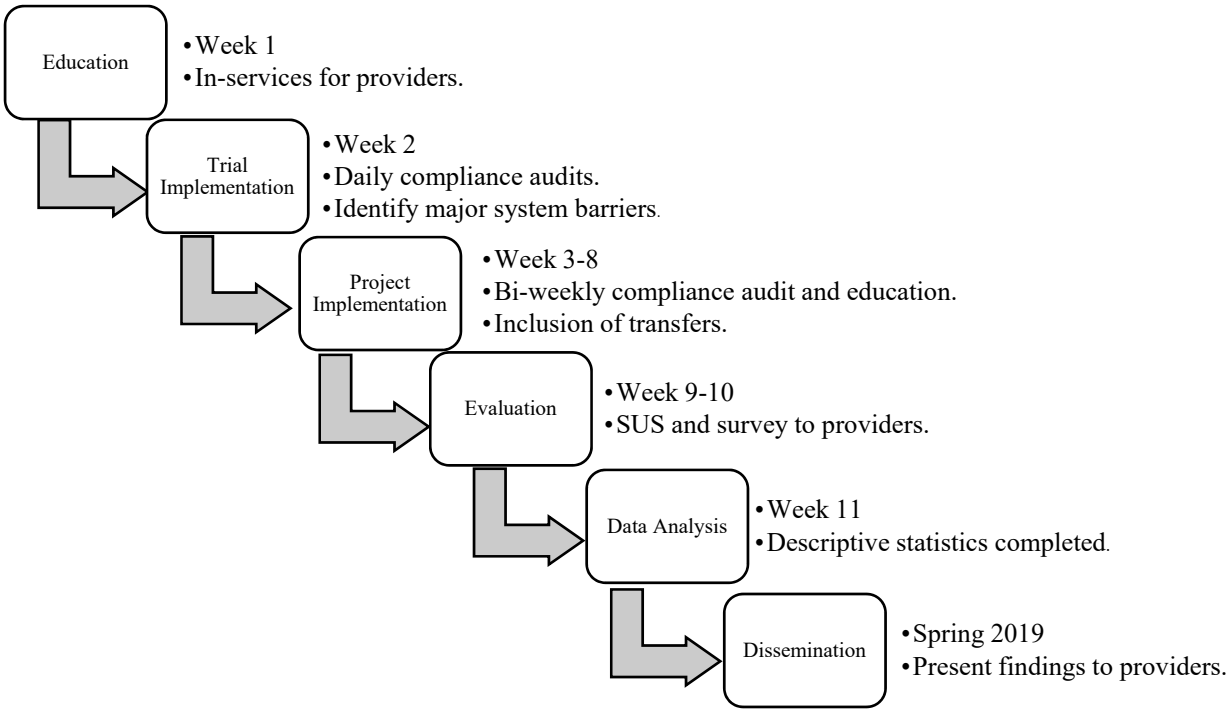

Figure 1. Diagram of Implementation Plan for Screening for Polypharmacy in the Elderly Population Project.

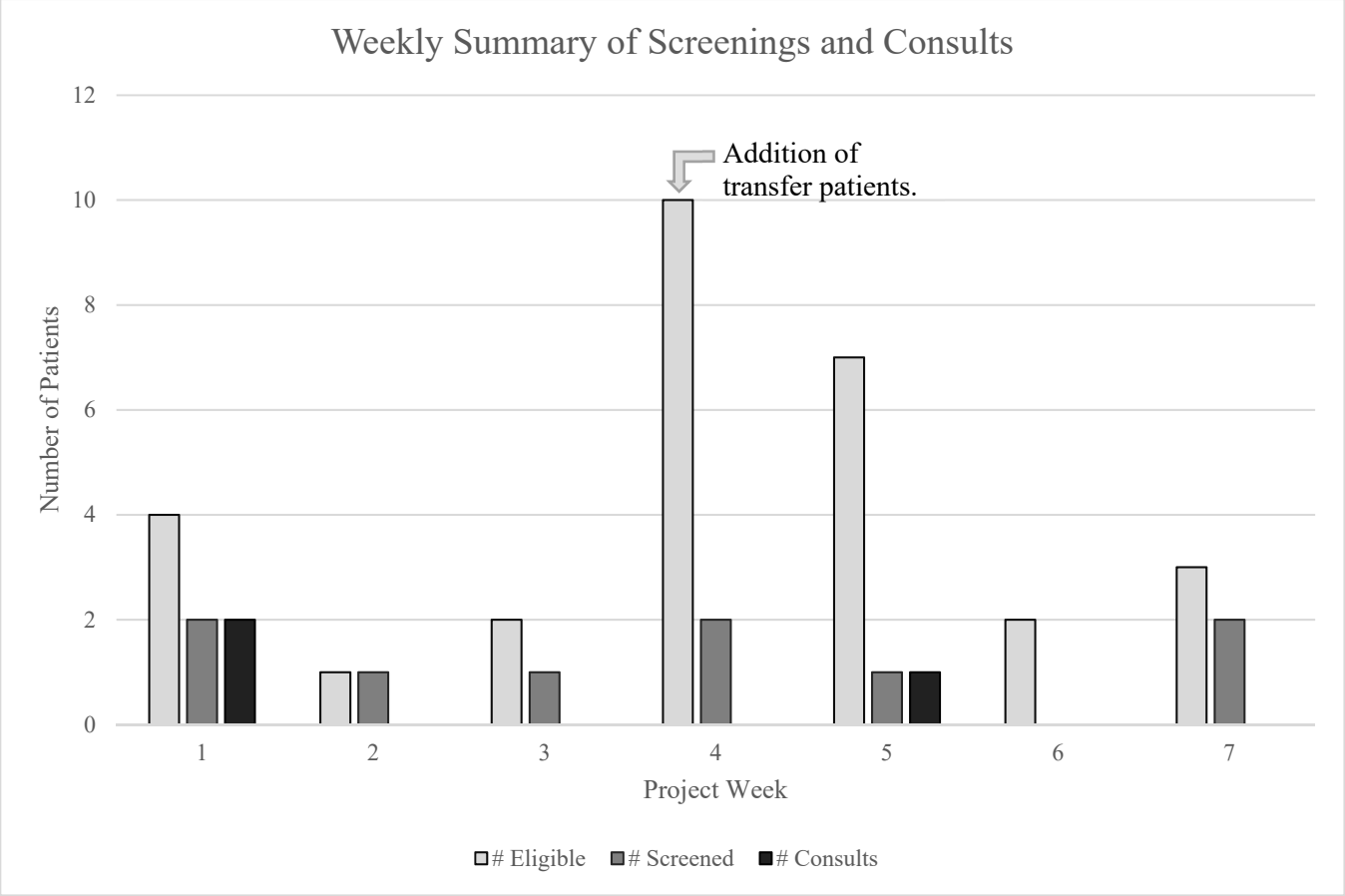

Figure 2. Summary of the number of eligible patients admitted to the General Neurology service, the number of screenings completed, and the number of consults received by the pharmacist each week.

Appendix A

Evidence Review Table

Author, year	Study objective/intervention or exposures compared	Design	Sample (N)	Outcomes studied (how measured)	Results	*Level and Quality Rating
Boland, et al., 2016	To compare the performance of the Beers criteria (2003 and 2012 versions) with the Screening Tool for Older People's Prescriptions (STOPP) / Screening Tool to Alert to Right Treatment (START) versions 1 and 2	Retrospective chart and data review. Randomly selected subjects were assessed using the four screening tools (Beers 2003 and 2012, STOPP/START versions 1 and 2).	*N* =20 (10%) patients over age 65 (76.7 ± 5.4 years, 55% female) from an acute geriatric medicine floor selected randomly from 200 consecutive admissions.	• Number of potentially inappropriate medications. • Number of medication omissions. • Number of medications prescribed. • Level of clinical significance for any medication changes.	Medications removed (*n*) Beers 2003 20 Beers 2012 30 STOPP v.1 40 STOPP v.2 85 Medications omitted (*n*) START v.1 28 START v.2 39 Mean medication reduction per patient (mean ± SD; median) Beers 2003 1.4 ± 1.6; 2; *p* = 0.035 Beers 2012 1.9 ± 1.7; 2; *p* < 0.021 STOPP/START v.1 2.0 ± 1.2; 2.5; *p* = 0.015 STOPP/START v.2 4.3 ± 2.3; 5; *p* < 0.001 Medication changes rated as having major clinical relevance (*n*) Beers 2003 6 Beers 2012 14 STOPP/START v.1 16 STOPP/START v.2 23	3 C
Hill-Taylor, et al., 2013	To conduct a systematic review of the evidence for the clinical, economic, and patient outcomes	Systematic review of evidence from literature databases between January	*N*=13 studies. Observational: *n*=12. RCT: *n*=1.	• Frequency of PIM • Frequency of PPO	Range of PIM reported in studies STOPP 21.4-79% Range of PPO reported in studies START 22.7-74%	3 B

	of the STOPP/START criteria.	2007 and January 2012.	Selection based on application of STOPP/START criteria in adults over age 65.	• Challenges for implementation • Comparison of STOPP/START to Beers for predicting ADEs. • Economic and clinical effects of STOPP/START	Studies identifying barriers to implementation (*n*): Requires multiple sources of information (5) Learning curve increases application time (1) Applied during transitions decreases effectiveness (1) Time for application (minutes) START 3 START/STOPP 3 – 4.5 Studies comparing to BEERS (*n)* START/STOPP more sensitive 6 BEERS more sensitive 0 START/STOPP decreased medication costs in 3 studies but insufficient data available on economic/clinical effects.	
O'Connor, et al., 2016	To assess the effect of the STOPP/START criteria on adverse drug events, medication costs, and length of hospital stay.	Single-blind randomized controlled trial. Study group screened with START/STOPP.	*N*=732 Consecutive patients at least 65 years old admitted to an Irish hospital. Control group: *n*=372 Study group: *n*=360	• Frequency of ADEs. • Median length of stay (LOS). • Medication expense for 28 days.	Study Group / Control Group ADE's 11.7% / 21% (*p*=0.001) Median LOS 8 days / 8 days Medication Expense €73.16 / €90.62 (*p*<0.001)	1 B
Vinluan, et al., 2017	To determine the ability of the STOPP criteria to identify potential adverse drug events (ADEs).	Retrospective chart review.	*N*=122 In-patients over age 65 (median age 75.7 ± 6.8 years, 55.7% male) with a documented ADE.	• Number of PIMs. • Number of ADEs associated with a PIM.	On admit / Hosp. Stay / Discharge PIM's (*n)* 115 / 90 / 85 Patients with PIM 67; 55.4% / 57: 46.7% / 57: 46.7%	3 B

• Time required to apply the criteria to the chart.	ADEs	22; 18.2%	16; 13.1%	10; 8.4%
	Time to screen	2 min	2 min	1 min
	13.3% of ADEs potentially preventable by STOPP criteria.			

Note. ADE = adverse drug events; ED = emergency department; PIM = potentially inappropriate medications; PPO = potential prescribing omissions; SD = standard deviation.

Appendix B

Screening Tool of Older Persons' Prescriptions (STOPP), version 2

The following prescriptions are potentially inappropriate to use in patients aged 65 years and older (O'Mahony et al., 2015).

Section A: Indication of medication

1. Any drug prescribed without an evidence-based clinical indication.

2. Any drug prescribed beyond the recommended duration, where treatment duration is well defined.

3. Any duplicate drug class prescription e.g. two concurrent NSAIDs, SSRIs, loop diuretics, ACE inhibitors, anticoagulants (optimisation of monotherapy within a single drug class should be observed prior to considering a new agent).

Section B: Cardiovascular System

1. Digoxin for heart failure with normal systolic ventricular function (no clear evidence of benefit).

2. Verapamil or diltiazem with NYHA Class III or IV heart failure (may worsen heart failure).

3. Beta-blocker in combination with verapamil or diltiazem (risk of heart block).

4. Beta blocker with bradycardia (< 50/min), type II heart block or complete heart block (risk of complete heart block, asystole).

5. Amiodarone as first-line antiarrhythmic therapy in supraventricular tachyarrhythmias (higher risk of side-effects than beta-blockers, digoxin, verapamil or diltiazem).

6. Loop diuretic as first-line treatment for hypertension (safer, more effective alternatives available).

7. Loop diuretic for dependent ankle oedema without clinical, biochemical evidence or radiological evidence of heart failure, liver failure, nephrotic syndrome or renal failure (leg elevation and /or compression hosiery usually more appropriate).

8. Thiazide diuretic with current significant hypokalaemia (i.e. serum K+ < 3.0 mmol/l), hyponatraemia (i.e. serum Na+ < 130 mmol/l) hypercalcaemia (i.e. corrected serum calcium > 2.65 mmol/l) or with a history of gout (hypokalaemia, hyponatraemia, hypercalcaemia and gout can be precipitated by thiazide diuretic).

9. Loop diuretic for treatment of hypertension with concurrent urinary incontinence (may exacerbate incontinence).

10. Centrally-acting antihypertensives (e.g. methyldopa, clonidine, moxonidine, rilmenidine, guanfacine), unless clear intolerance of, or lack of efficacy with, other classes of antihypertensives (centrally-active antihypertensives are generally less well tolerated by older people than younger people).

11. ACE inhibitors or Angiotensin Receptor Blockers in patients with hyperkalaemia.

12. Aldosterone antagonists (e.g. spironolactone, eplerenone) with concurrent potassium-conserving drugs (e.g. ACEI's, ARB's, amiloride, triamterene) without monitoring of serum potassium (risk of dangerous hyperkalaemia i.e. > 6.0 mmol/l – serum K should be monitored regularly, i.e. at least every 6 months).

13. Phosphodiesterase type-5 inhibitors (e.g. sildenafil, tadalafil, vardenafil) in severe heart failure characterised by hypotension i.e. systolic BP < 90 mmHg, or concurrent nitrate therapy for angina (risk of cardiovascular collapse).

Section C: Antiplatelet/Anticoagulant Drugs

1. Long-term aspirin at doses greater than 160mg per day (increased risk of bleeding, no evidence for increased efficacy).

2. Aspirin with a past history of peptic ulcer disease without concomitant PPI (risk of recurrent peptic ulcer).

3. Aspirin, clopidogrel, dipyridamole, vitamin K antagonists, direct thrombin inhibitors or factor Xa inhibitors with concurrent significant bleeding risk, i.e. uncontrolled severe hypertension, bleeding diathesis, recent non-trivial spontaneous bleeding) (high risk of bleeding).

4. Aspirin plus clopidogrel as secondary stroke prevention, unless the patient has a coronary stent(s) inserted in the previous 12 months or concurrent acute coronary syndrome or has a high grade symptomatic carotid arterial stenosis (no evidence of added benefit over clopidogrel monotherapy).

5. Aspirin in combination with vitamin K antagonist, direct thrombin inhibitor or factor Xa inhibitors in patients with chronic atrial fibrillation (no added benefit from aspirin).

6. Antiplatelet agents with vitamin K antagonist, direct thrombin inhibitor or factor Xa inhibitors in patients with stable coronary, cerebrovascular or peripheral arterial disease (No added benefit from dual therapy).

7. Ticlopidine in any circumstances (clopidogrel and prasugrel have similar efficacy, stronger evidence and fewer side-effects).

8. Vitamin K antagonist, direct thrombin inhibitor or factor Xa inhibitors for first deep venous thrombosis without continuing provoking risk factors (e.g. thrombophilia) for > 6 months, (no proven added benefit).

9. Vitamin K antagonist, direct thrombin inhibitor or factor Xa inhibitors for first pulmonary embolus without continuing provoking risk factors (e.g. thrombophilia) for > 12 months (no proven added benefit).

10. NSAID and vitamin K antagonist, direct thrombin inhibitor or factor Xa inhibitors in combination (risk of major gastrointestinal bleeding).

11. NSAID with concurrent antiplatelet agent(s) without PPI prophylaxis (increased risk of peptic ulcer disease).

Section D: Central Nervous System and Psychotropic Drugs

1. TriCyclic Antidepressants (TCAs) with dementia, narrow angle glaucoma, cardiac conduction abnormalities, prostatism, or prior history of urinary retention (risk of worsening these conditions).

2. Initiation of TriCyclic Antidepressants (TCAs) as first-line antidepressant treatment (higher risk of adverse drug reactions with TCAs than with SSRIs or SNRIs).

3. Neuroleptics with moderate-marked antimuscarinic/anticholinergic effects (chlorpromazine, clozapine, flupenthixol, fluphenzine, pipothiazine, promazine, zuclopenthixol) with a history of prostatism or previous urinary retention (high risk of urinary retention).

4. Selective serotonin re-uptake inhibitors (SSRI's) with current or recent significant hyponatraemia i.e. serum Na+ < 130 mmol/l (risk of exacerbating or precipitating hyponatraemia).

5. Benzodiazepines for ≥ 4 weeks (no indication for longer treatment; risk of prolonged sedation, confusion, impaired balance, falls, road traffic accidents; all benzodiazepines should be withdrawn gradually if taken for more than 4 weeks as there is a risk of causing a benzodiazepine withdrawal syndrome if stopped abruptly).

6. Antipsychotics (i.e. other than quetiapine or clozapine) in those with parkinsonism or Lewy Body Disease (risk of severe extra-pyramidal symptoms).

7. Anticholinergics/antimuscarinics to treat extra-pyramidal side-effects of neuroleptic medications (risk of anticholinergic toxicity).

8. Anticholinergics/antimuscarinics in patients with delirium or dementia (risk of exacerbation of cognitive impairment).

9. Neuroleptic antipsychotic in patients with behavioural and psychological symptoms of dementia (BPSD) unless symptoms are severe and other non-pharmacological treatments have failed (increased risk of stroke).

10. Neuroleptics as hypnotics, unless sleep disorder is due to psychosis or dementia (risk of confusion, hypotension, extra-pyramidal side effects, falls).

11. Acetylcholinesterase inhibitors with a known history of persistent bradycardia (< 60 beats/min.), heart block or recurrent unexplained syncope or concurrent treatment with drugs that reduce heart rate such as beta-blockers, digoxin, diltiazem, verapamil (risk of cardiac conduction failure, syncope and injury).

12. Phenothiazines as first-line treatment, since safer and more efficacious alternatives exist (phenothiazines are sedative, have significant anti-muscarinic toxicity in older people, with the exception of prochlorperazine for nausea/vomiting/vertigo, chlorpromazine for relief of persistent hiccoughs and levomepromazine as an anti-emetic in palliative care).

13. Levodopa or dopamine agonists for benign essential tremor (no evidence of efficacy)

14. First-generation antihistamines (safer, less toxic antihistamines now widely available).

Section E: Renal System.

The following drugs are potentially inappropriate in older people with acute or chronic kidney disease with renal function below particular levels of eGFR (refer to summary of product characteristics datasheets and local formulary guidelines).

1. Digoxin at a long-term dose greater than 125µg/day if eGFR < 30 ml/min/1.73m2 (risk of digoxin toxicity if plasma levels not measured).

2. Direct thrombin inhibitors (e.g. dabigatran) if eGFR < 30 ml/min/1.73m2 (risk of bleeding)

3. Factor Xa inhibitors (e.g. rivaroxaban, apixaban) if eGFR < 15 ml/min/1.73m2 (risk of bleeding)

4. NSAID's if eGFR < 50 ml/min/1.73m2 (risk of deterioration in renal function).

5. Colchicine if eGFR < 10 ml/min/1.73m2 (risk of colchicine toxicity).

6. Metformin if eGFR < 30 ml/min/1.73m2 (risk of lactic acidosis).

Section F: Gastrointestinal System

1. Prochlorperazine or metoclopramide with Parkinsonism (risk of exacerbating Parkinsonian symptoms).

2. PPI for uncomplicated peptic ulcer disease or erosive peptic oesophagitis at full therapeutic dosage for > 8 weeks (dose reduction or earlier discontinuation indicated).

3. Drugs likely to cause constipation (e.g. antimuscarinic/anticholinergic drugs, oral iron, opioids, verapamil, aluminium antacids) in patients with chronic constipation where non-constipating alternatives are available (risk of exacerbation of constipation).

4. Oral elemental iron doses greater than 200 mg daily (e.g. ferrous fumarate> 600 mg/day, ferrous sulphate > 600 mg/day, ferrous gluconate> 1800 mg/day; no evidence of enhanced iron absorption above these doses).

Section G: Respiratory System

1. Theophylline as monotherapy for COPD (safer, more effective alternative; risk of adverse effects due to narrow therapeutic index).

2. Systemic corticosteroids instead of inhaled corticosteroids for maintenance therapy in moderate-severe COPD (unnecessary exposure to long-term side-effects of systemic corticosteroids and effective inhaled therapies are available).

3. Anti-muscarinic bronchodilators (e.g. ipratropium, tiotropium) with a history of narrow angle glaucoma (may exacerbate glaucoma) or bladder outflow obstruction (may cause urinary retention).

4. Non-selective beta-blocker (whether oral or topical for glaucoma) with a history of asthma requiring treatment (risk of increased bronchospasm).

5. Benzodiazepines with acute or chronic respiratory failure i.e. $pO2 < 8.0$ kPa ± $pCO2 > 6.5$ kPa (risk of exacerbation of respiratory failure).

Section H: Musculoskeletal System

1. Non-steroidal anti-inflammatory drug (NSAID) other than COX-2 selective agents with history of peptic ulcer disease or gastrointestinal bleeding, unless with concurrent PPI or H2 antagonist (risk of peptic ulcer relapse).

2. NSAID with severe hypertension (risk of exacerbation of hypertension) or severe heart failure (risk of exacerbation of heart failure).

3. Long-term use of NSAID (>3 months) for symptom relief of osteoarthritis pain where paracetamol has not been tried (simple analgesics preferable and usually as effective for pain relief).

4. Long-term corticosteroids (>3 months) as monotherapy for rheumatoid arthrtitis (risk of systemic corticosteroid side-effects).

5. Corticosteroids (other than periodic intra-articular injections for mono-articular pain) for osteoarthritis (risk of systemic corticosteroid side-effects).

6. Long-term NSAID or colchicine (>3 months) for chronic treatment of gout where there is no contraindication to a xanthine-oxidase inhibitor (e.g. allopurinol, febuxostat) (xanthine-oxidase inhibitors are first choice prophylactic drugs in gout).

7. COX-2 selective NSAIDs with concurrent cardiovascular disease (increased risk of myocardial infarction and stroke).

8. NSAID with concurrent corticosteroids without PPI prophylaxis (increased risk of peptic ulcer disease).

9. Oral bisphosphonates in patients with a current or recent history of upper gastrointestinal disease i.e. dysphagia, oesophagitis, gastritis, duodenitis, or peptic ulcer disease, or upper gastrointestinal bleeding (risk of relapse/exacerbation of oesophagitis, oesophageal ulcer, oesophageal stricture).

Section I: Urogenital System

1. Antimuscarinic drugs with dementia, or chronic cognitive impairment (risk of increased confusion, agitation) or narrow-angle glaucoma (risk of acute exacerbation of glaucoma), or chronic prostatism (risk of urinary retention).

2. Selective alpha-1 selective alpha blockers in those with symptomatic orthostatic hypotension or micturition syncope (risk of precipitating recurrent syncope).

Section J. Endocrine System

1. Sulphonylureas with a long duration of action (e.g. glibenclamide, chlorpropamide, glimepiride) with type 2 diabetes mellitus (risk of prolonged hypoglycaemia).

2. Thiazolidenediones (e.g. rosiglitazone, pioglitazone) in patients with heart failure (risk of exacerbation of heart failure)

3. Beta-blockers in diabetes mellitus with frequent hypoglycaemic episodes (risk of suppressing hypoglycaemic symptoms).

4. Oestrogens with a history of breast cancer or venous thromboembolism (increased risk of recurrence).

5. Oral oestrogens without progestogen in patients with intact uterus (risk of endometrial cancer).

6. Androgens (male sex hormones) in the absence of primary or secondary hypogonadism (risk of androgen toxicity; no proven benefit outside of the hypogonadism indication).

Section K: Drugs that predictably increase the risk of falls in older people

1. Benzodiazepines (sedative, may cause reduced sensorium, impair balance).

2. Neuroleptic drugs (may cause gait dyspraxia, Parkinsonism).

3. Vasodilator drugs (e.g. alpha-1 receptor blockers, calcium channel blockers, long-acting nitrates, ACE inhibitors, angiotensin I receptor blockers,) with persistent postural hypotension i.e. recurrent drop in systolic blood pressure ≥ 20mmHg (risk of syncope, falls).

4. Hypnotic Z-drugs e.g. zopiclone, zolpidem, zaleplon (may cause protracted daytime sedation, ataxia).

Section L: Analgesic Drugs

1. Use of oral or transdermal strong opioids (morphine, oxycodone, fentanyl, buprenorphine, diamorphine, methadone, tramadol, pethidine, pentazocine) as first line therapy for mild pain (WHO analgesic ladder not observed).

2. Use of regular (as distinct from PRN) opioids without concomitant laxative (risk of severe constipation).

3. Long-acting opioids without short-acting opioids for break-through pain (risk of persistence of severe pain).

Section N: Antimuscarinic/Anticholinergic Drug Burden

Concomitant use of two or more drugs with antimuscarinic/anticholinergic properties (e.g. bladder antispasmodics, intestinal antispasmodics, tricyclic antidepressants, first generation antihistamines) (risk of increased antimuscarinic/anticholinergic toxicity).

Appendix C

Screening Tool to Alert to Right Treatment (START), version 2

Unless an elderly patient's clinical status is end-of-life and therefore requiring a more palliative focus of pharmacotherapy, the following drug therapies should be considered where omitted for no valid clinical reason (O'Mahony, et al., 2015). It is assumed that the prescriber observes all the specific contraindications to these drug therapies prior to recommending them to older patients.

Section A: Cardiovascular System

1. Vitamin K antagonists or direct thrombin inhibitors or factor Xa inhibitors in the presence of chronic atrial fibrillation.

2. Aspirin (75 mg – 160 mg once daily) in the presence of chronic atrial fibrillation, where Vitamin K antagonists or direct thrombin inhibitors or factor Xa inhibitors are contraindicated.

3. Antiplatelet therapy (aspirin or clopidogrel or prasugrel or ticagrelor) with a documented history of coronary, cerebral or peripheral vascular disease.

4. Antihypertensive therapy where systolic blood pressure consistently > 160 mmHg and/or diastolic blood pressure consistently >90 mmHg; if systolic blood pressure > 140 mmHg and /or diastolic blood pressure > 90 mmHg, if diabetic.

5. Statin therapy with a documented history of coronary, cerebral or peripheral vascular disease, unless the patient's status is end-of-life or age is > 85 years.

6. Angiotensin Converting Enzyme (ACE) inhibitor with systolic heart failure and/or documented coronary artery disease.

7. Beta-blocker with ischaemic heart disease.

8. Appropriate beta-blocker (bisoprolol, nebivolol, metoprolol or carvedilol) with stable systolic heart failure.

Section B: Respiratory System

1. Regular inhaled β2 agonist or antimuscarinic bronchodilator (e.g. ipratropium, tiotropium) for mild to moderate asthma or COPD.

2. Regular inhaled corticosteroid for moderate-severe asthma or COPD, where FEV1 <50% of predicted value and repeated exacerbations requiring treatment with oral corticosteroids.

3. Home continuous oxygen with documented chronic hypoxaemia (i.e. pO2 < 8.0 kPa or 60 mmHg or SaO2 < 89%).

Section C: Central Nervous System & Eyes

1. L-DOPA or a dopamine agonist in idiopathic Parkinson's disease with functional impairment and resultant disability.

2. Non-TCA antidepressant drug in the presence of persistent major depressive symptoms.

3. Acetylcholinesterase inhibitor (e.g. donepezil, rivastigmine, galantamine) for mild-moderate Alzheimer's dementia or Lewy Body dementia (rivastigmine).

4. Topical prostaglandin, prostamide or beta-blocker for primary open-angle glaucoma.

5. Selective serotonin reuptake inhibitor (or SNRI or pregabalin if SSRI contraindicated) for persistent severe anxiety that interferes with independent functioning.

6. Dopamine agonist (ropinirole or pramipexole or rotigotine) for Restless Legs Syndrome, once iron deficiency and severe renal failure have been excluded.

Section D: Gastrointestinal System

1. Proton Pump Inhibitor with severe gastro-oesophageal reflux disease or peptic stricture requiring dilatation.

2. Fibre supplements (e.g. bran, ispaghula, methylcellulose, sterculia) for diverticulosis with a history of constipation.

Section E: Musculoskeletal System

1. Disease-modifying anti-rheumatic drug (DMARD) with active, disabling rheumatoid disease.

2. Bisphosphonates and vitamin D and calcium in patients taking long-term systemic corticosteroid therapy.

3. Vitamin D and calcium supplement in patients with known osteoporosis and/or previous fragility fracture(s) and/or (Bone Mineral Density T-scores more than -2.5 in multiple sites).

4. Bone anti-resorptive or anabolic therapy (e.g. bisphosphonate, strontium ranelate, teriparatide, denosumab) in patients with documented osteoporosis, where no pharmacological or clinical status contraindication exists (Bone Mineral Density T-scores -> 2.5 in multiple sites) and/or previous history of fragility fracture(s).

5. Vitamin D supplement in older people who are housebound or experiencing falls or with osteopenia (Bone Mineral Density T-score is > -1.0 but < -2.5 in multiple sites).

6. Xanthine-oxidase inhibitors (e.g. allopurinol, febuxostat) with a history of recurrent episodes of gout.

7. Folic acid supplement in patients taking methotexate.

Section F: Endocrine System

1. ACE inhibitor or Angiotensin Receptor Blocker (if intolerant of ACE inhibitor) in diabetes with evidence of renal disease i.e. dipstick proteinuria or microalbuminuria (>30mg/24 hours) with or without serum biochemical renal impairment.

Section G: Urogenital System

1. Alpha-1 receptor blocker with symptomatic prostatism, where prostatectomy is not considered necessary.

2. 5-alpha reductase inhibitor with symptomatic prostatism, where prostatectomy is not considered necessary.

3. Topical vaginal oestrogen or vaginal oestrogen pessary for symptomatic atrophic vaginitis.

Section H: Analgesics

1. High-potency opioids in moderate-severe pain, where paracetamol, NSAIDs or low-potency opioids are not appropriate to the pain severity or have been ineffective.

2. Laxatives in patients receiving opioids regularly.

Section I: Vaccines

1. Seasonal trivalent influenza vaccine annually.

2. Pneumococcal vaccine at least once after age 65 according to national guidelines.

Appendix D

MAP-IT Worksheet

DNP Project Name: Screening for Polypharmacy in the Elderly Population

DNP Project Purpose Statement: The purpose of this DNP project is to implement and evaluate the usability of a screening tool to identify polypharmacy and initiate consultation with a Clinical Pharmacy Specialist to evaluate for potentially inappropriate medications in patients over age 65 admitted to the general Neurology service.

Short-Term SMART Objective:
Objective 1: By November 30, 2018, 80% of patients over age 65 admitted to the general Neurology service will be screened for polypharmacy using the STOPP/START tool.

Objective 2: By November 30, 2018, 80% of patients identified with a potentially inappropriate medication or potential prescribing omission by the STOPP/START tool will have a consult initiated for a Clinical Pharmacy Specialist.

Long-Term SMART Objective:
Objective 1: By November 30, 2019, there will be a significant decrease in the prevalence of adverse drug events among patients over age 65 on the general Neurology service.

Objective 2: By November 30, 2019, the outcomes associated with the STOPP/START implementation will have revealed the positive clinical and economic effect of additional pharmacy support for the Neurology floor.

Population/Context: Patients over age 65 admitted to the general Neurology service at a large urban quaternary academic medical center are the target population. Patients over age 65 are more likely to experience polypharmacy compared to other age groups (National Center for Health Statistics, 2017).

Mobilize:
List of Core Team Members
Michael Armahizer, PharmD. Dr. Armahizer will receive the pharmacy consults generated by the screening and will track the number of consults and whether or not he made a recommendation for change.
Joseph Haymore, DNP. Dr. Haymore is a provider on the Neurology team and will assist in implementing the screening and identifying appropriate strategies and champions to assist.
Brett Weir, RN. Brett is the project leader.

Others I will mobilize after the draft plans have been developed
Neurology chief resident, residents, and other providers. The providers are vital to the success of the implementation. The scheduled resident rotations will be reviewed for the planned implementation time frame to identify which individuals will need to be specifically mobilized.

Assess: *WHAT structures and processes (practices) need to change and WHY? What structure, process, and outcome measures will be used to measure progress?*
There is currently no screening system for polypharmacy on the Neurology service and no formal process for initiating a consult to the clinical pharmacist for patients outside of the Neuro ICU. Polypharmacy is associated with an increased risk of adverse drug events (Barclay et al., 2018; Poudel et al., 2017). Incorporating a screening tool for polypharmacy into the practice of the Neurology providers will assist in identifying patients at higher risk of adverse drug events and provide clear criteria for consulting the clinical pharmacist. Progress will be measured by evaluating the provider's compliance with screening eligible patients and initiating a consult to the clinical pharmacist for any positive findings. Additionally, the usability of the screening tool will be assessed with a survey of the providers following implementation.

Plan: *HOW will these changes be made (strategies and tactics)? WHEN will these changes be made?*
The STOPP/START tool will be integrated into the medication reconciliation process when a patient is admitted to the Neurology service. Prior to implementation, the project leader will meet with the additional Neurology providers and chief residents to determine the most appropriate time for completing the screening. At this meeting, the Neurology providers will be educated on the purpose and goals of the implementation. Within 48 hours of admission, eligible patients will be screened using the tool. If the screening tool identifies a potentially inappropriate medication (PIM) or potential prescribing omission (PPO), then the Neurology provider will initiate a clinical pharmacy consult. The consults generated by the screening will go directly to the Clinical Pharmacy Specialist who will track the number of consults he receives and whether or not he makes a recommendation for change after evaluating the patient. Regardless of the findings of the screening, the physical copy of the tool will be placed in a sealed collection box in the Neurology staff room. The project coordinator will collect the completed screenings twice weekly and compare them to the number of eligible patients admitted to the Neurology service to determine compliance. The number of positive tools will then be compared with the number of consults recorded by the Clinical Pharmacy Specialist to establish compliance. Following the implementation, the Neurology providers will complete a survey to assess the usability of the screening tool. The implementation will begin in September 2018 based on the resident rotation schedule with a goal for practice change to be evident by greater than 80% compliance by November 30, 2018.

Implement: *WHAT strategies and tactics were used? WHEN were the desired changes made?*
The STOPP/START criteria were added to the medication reconciliation process for the General Neurology service starting in October 2018. For the first week, daily education and guidance was provided by the project coordinator. During this week, it became evident that the screening was being primarily delegated to the medical students, requiring additional education sessions to provide them with the required training. After the first two weeks, transfer patients were added due to a low volume of eligible patients. Also during week 3, the resident team changed over, requiring retraining for the new providers.

Track: *WHAT structures and processes (practices) were changed based on the metrics we used to measure progress (including frequency of assessment)? HOW did these changes affect outcomes? WHAT do we need to do differently to make greater progress toward improving outcomes?*
Based on the low compliance numbers, the medication reconciliation process was not effectively changed, particularly among the resident physicians. All of the screenings were completed by either the medical students or the nurse practitioners. Based on these screenings, pharmacy involvement in medication assessment was increased, although this involvement did not result in any medication changes. The providers themselves used the criteria to make two medication changes. Although the criteria were not consistently used for screening as desired, they were reportedly used to initiate medication appropriate conversations during patient rounding. In order to better integrate the criteria into this process, there must be more buy-in from the residents. Additionally, eliminating the additional paper work required specifically for data tracking with this project would increase compliance. Finally, an electronic version of the criteria or requiring documentation of the screening in the patient record would also increase compliance.

Date: April 30, 2018 Re-Assessment Date 1: October 30, 2018 Re-Assessment Date 2: November 30, 2018.

Plan Developed by (List all contributors): Brett S. Weir; Joseph Haymore, DNP; Mike Armahizer, PharmD, Linda Costa, PhD_____

The Institute for Perinatal Quality Improvement (PQI) grants the University of Maryland School of Nursing permission to utilize and make modifications to PQI's MAP-IT worksheet to support the DNP students learning.

For permission to further modify or utilize PQI's MAP-IT worksheet in other settings contact: info@perinatalQI.org.

Reference: Guidry, M., Vischi, T., Han, R., & Passons, O. MAP-IT: a guide to using healthy people 2020 in your community. U.S. Department of Health and Human Services. The Office of Disease Prevention and Health Promotion, Washington, D.C. https://www.healthypeople.gov/2020/tools-and-resources/Program-Planning

Appendix E

Lesson Plan for Project Implementation Educational In-Service

Learning Objectives	Content Outline	Method of Instruction	Time Spent	Method of Evaluation
The providers will verbalize the purpose of this project and the literature support for polypharmacy screening.	1. Incidence and impact of polypharmacy on healthcare. 2. Purpose of this project to implement a polypharmacy screening tool. 3. Value of project participation to include identification of polypharmacy in assigned patients and increased utilization of clinical pharmacy support.	Oral Presentation	5 minutes	Verbal confirmation at conclusion of presentation.
The providers will be able to accurately apply the STOPP/START criteria to identify any PIMs or PPOs on eligible patients.	1. Overview of the STOPP/START criteria. 2. Example application of the criteria to a patient. 3. Location of criteria forms and process for collection.	Oral Presentation, Demonstration, Practical Application	10 minutes	Demonstration of application on sample patient. Audits by PC.
The providers will demonstrate the process for obtaining a clinical pharmacy consult.	1. A consult is initiated for any positive finding on the STOPP/START criteria. 2. The consult is placed directly to the assigned Clinical Pharmacist via secure messaging.	Oral Presentation, Demonstration, Practical Application	10 minutes	Verbal confirmation of consult process. Demonstration of consult placement.

Appendix F

System Usability Scale

	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1. I think that I would like to use this product frequently.	1	2	3	4	5
2. I found the product unnecessarily complex.	1	2	3	4	5
3. I thought the product was easy to use.	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this product.	1	2	3	4	5
5. I found the various functions in this product were well integrated.	1	2	3	4	5
6. I thought there was too much inconsistency in this product.	1	2	3	4	5
7. I would imagine that most people would learn to use this product very quickly.	1	2	3	4	5
8. I found the product very awkward to use.	1	2	3	4	5
9. I felt very confident using the product.	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this product.	1	2	3	4	5

Note. Adapted from "Item Benchmarks for the System Usability Scale" by J. R. Lewis & J. Sauro, 2018, *Journal of Usability Statistics, 13*(3), 158-167.

Appendix G

Additional Survey Questions

1. Describe any barriers you noticed to the implementation of the STOPP/START criteria.

2. Describe any facilitators that assisted in the implementation process of the STOPP/START criteria.

3. What did you like about the STOPP/START criteria?

4. What would you change about the STOPP/START criteria?

Appendix H

Scoring the System Usability Scale

1. For questions 1, 3, 5, 7, and 9, subtract 1 from the item score for the item contribution total.

2. For questions 2, 4, 6, 8, and 10, subtract the item score from 5 for the item contribution total.

3. Add all of the item contribution totals and multiple by 2.5.

4. Scores range from zero (very poor perceived usability) to 100 (excellent perceived usability).

Note. Adapted from "Item Benchmarks for the System Usability Scale" by J. R. Lewis & J. Sauro, 2018, *Journal of Usability Statistics, 13*(3), 158-167.

Appendix I

Project Proposal Summary

Over 40% of people over age 65 take more than five daily medications (National Center for Health Statistics, 2017). This increased medication use among the elderly is associated with higher rates of adverse drug events (ADEs) and an increased likelihood for potentially inappropriate prescriptions (PIMs) (Poudel, Acharya, Ghimire, Dhital, & Bharati, 2017). Conversely, up to 74% of the elderly population have been identified as having a potential prescribing omission (PPOs) (Hill-Taylor et al., 2013). These inappropriate medication regimens are associated with an increased risk of ADEs (Poudel et al., 2017). Currently, there is no standardized process for screening patients for polypharmacy at the practice site.

The purpose of this quality improvement project is to implement and evaluate the usability of a screening tool to identify polypharmacy and initiate consultation with a Clinical Pharmacy Specialist (CPS) to evaluate for potentially inappropriate medications in patients over age 65 admitted to the general Neurology service. The Screening Tool for Older Person's Prescriptions (STOPP) and Screening to Alert to Right Treatment (START) criteria will be implemented as part of the medication reconciliation process. The STOPP/START criteria have been shown to identify more PIMs than the well-known Beers Criteria and in a randomized-controlled trial, resulted in a significant decrease in the number of ADEs (p=0.001) (Hill-Taylor et al., 2013; O'Connor et al., 2016). The providers on the general Neurology service will use the STOPP/START criteria to screen all patients over age 65 who are admitted to the service. A positive finding will result in a consult to the CPS. The providers will be monitored for compliance in both the screening of eligible patients and the initiation of a consult for positive findings. The CPS will record the number of consults received and whether or not a recommendation was made.

The implementation will follow an eleven-week timeline. In the first week, the project coordinator (PC) will provide training to the providers regarding the application of the STOPP/START criteria. Week two will serve as a trial implementation period with daily audits and continuing education by the PC. Weeks three through eight will be the official study period. During this time, the PC will conduct bi-weekly collection of the screenings. Additional individualized education will be provided as necessary. Following the study period, there will be a two-week evaluation during which the providers will be surveyed with the System Usability Scale (SUS) augmented with four open-ended questions regarding the implementation. The final week of the project will be used for data analysis.

Data collection will be conducted with the STOPP/START criteria and the SUS. The results of the STOPP/START screening will be collected in a de-identified, dichotomous flowsheet of either positive or negative findings. The total number of eligible patients admitted to the service will be collected for comparison. Following the implementation, the criteria will be assessed using the SUS in the form of a survey for the providers. The SUS is a valid, reliable tool that has become the standard for assessing usability across a wide variety of systems (Lewis & Sauro, 2018; Brooke, 2013). The data will be analyzed using descriptive statistics in Microsoft Excel with a primary focus on compliance percentages for screening and consult, and the mean, frequency, and standard deviation for SUS scores. The goals of the project are to achieve 80% compliance with both screening and completion of a pharmacy consult, thereby providing an effective, sustainable method of screening for polypharmacy.

Appendix J

STOPP/START Screening Results Form

Date: _____ Person completing screening: _____

Please select the following as applicable (you may select more than one option):

☐ Positive finding on STOPP.

☐ Positive finding on START.

☐ No findings.

☐ Consult placed to pharmacy.