Background

According to the Agency for Healthcare Research and Quality 2001, a Patient Safety Practice is a type of process or structure whose application reduces the probability of adverse events from exposure to the healthcare system across many diseases and procedures (Shojania, et al., 2001). Applying theoretically based analytical approaches to healthcare risk moves strategies forward to mitigate harm and prevent medical errors. This patient safety initiative focuses on analysis of errors in the Preventive Health Assessment and Individual Medical Readiness (PIMR) system using Complex Adaptive System Theory (Clancy, 2010)

Purpose

The objectives of analyzing near misses and events in an outpatient military treatment facility were twofold: 1 to define and employ a theoretical basis for processing events with possible harm to patients, and, 2 to implement changes based on evidence from the analysis of such events (Kitson, 2008).

Theoretical Framework

Complex Adaptive System Theory (Stacey, 2007) captures the link between an event and the affect on the healthcare organization. General System Theory directs processes in a linear manner, but healthcare institutions exist as complex non-linear organizations with varied sets of elements, such as human behavior and communication, technological interfaces, socio-cultural factors and a range of organizational and procedural limitations. Each individual working in the facility and the patient interacting within the facility constitute agents involved in repetitive, nonlinear interactions, according to the Complex Adaptive System Theory (See Figure 1). Therefore, Complex Adaptive System Theory with non-linear dynamics provides a useful framework for studying the risk caused by errors in a clinical setting.

Design

Case study design (Stommel & Wills, 2004) directed the collection of qualitative and quantitative data. Case study methodology explores phenomena in a real world setting and provides an approach for analysis of infrequently occurring events. Case studies elucidate the mechanisms underlying the adverse events with highly detailed information on each case (Duthie, 2010).

Resources

The Patient Safety Department receives all near-miss and event reports under the direction of the Medical Group Commander. All events reaching the level of the patient undergo a comprehensive review and interviews of all parties involved ensue with full support and review by the leadership group.

Methodology

Qualitative: Case study methodology involved the collection of qualitative data. Qualitative data incorporated interviews with key informants. Using unstructured individual interviews, patient safety interviewed the staff, managers and healthcare providers directly involved with events. The interview process elucidated the following case events involving the PIMR record.

Case # one involved the incorrect entry into the PIMR database of the wrong name on a pregnant active duty member (See Figure 2). Consequently, the wrong active

duty member's commander received the report about the pregnancy status. This individual (the wrong active duty member who really was not pregnant) was set to deploy. The commander scrambled to find another placement to deploy. A review of the situation found that the wrong name went into the PIMR database. A HIPAA violation occurred in the process with the switching of the information on the two patients.

Case # two entailed a circumstance similar to case # one with another incorrect name entered into the PIMR database. This second situation differed as the condition involved a mental health diagnosis. The wrong commander received the notification and called in the active duty member to discuss the mental health situation, but the active duty member denied any mental health problems. Appraisal of the situation uncovered the wrong name entry into the database.

Case # three cropped up with the entry into the PIMR database of a diagnosis code for sleep apnea when the patient's condition involved lower back pain. The staff ordered equipment for sleep apnea, but after communicating with the patient, an examination of the electronic health record found the diagnosis listed incorrectly in the PIMR database. The situation produced no harm to the patient.

Case # four resulted from another incorrect diagnosis entry into the PIMR database. The patient suffered a shoulder sprain with rotator cuff, but a diagnosis for knee sprain appeared in the PIMR database. The wrong therapy was ordered.

Quantitative: The patient safety staff first audited the current medical diagnosis and ICD-9 code documentation in the electronic medical record, the staff PIMR worksheet to capture data for entry in to the PIMR system and the documentation in the PIMR database data. A second audit using the same criteria as the first audit transpired two weeks after implementation of a new PIMR worksheet.

Analysis/ Evaluation
The qualitative and quantitative data collection completed the data collection process. Patient Safety conducted interviews on seven members of the medical group and reviewed a total of 109 electronic records over a two month timeframe.. The statistical program, JMP version 8.0, SAS Institute, Inc. 2008 analyzed the quantitative data. A Chi Square analysis compared the scores between the pre-assessment and post-assessment audit. The alpha level of significance was set at $p < 0.05$.

The ultimate measurement of success or outcome relies on the implementation of a new process for the prevention of errors in the long-term. The implementation of a revised PIMR worksheet supplied a process improvement.

Results: The use of Complex Adaptive System Theory allows one to look at how the parts of the system fit together. A pattern or order of relationships exists in every clinical situation. In the case of the entry of key data into the PIMR system, the process involves the patient, the healthcare provider and the medical technician or nurse. The staff described the process outlined in Figure 2. The ideal situation ensues when all the information on the worksheet is accurate with the correct information going into the PIMR database. The concept of non-linear

disorganization or ineffective entry of data from complexity theory may ensue due to intervening components (Holden, 2005). Intervening factors may include such issues as a lack of time to complete information on the worksheet, failure to use two identifiers when entering patient information, lack of knowledge about ICD-9 codes, etc.

In addition to the system process, the staff identified problem areas with the PIMR worksheet. Table 1 itemizes some of the issues identified by key stakeholders. The main patient safety concern of using two patient identifiers stood out. The event cases involved wrong diagnoses and revealed problems with ICD-9 codes, E codes for injuries and written diagnosis inconsistencies in the record. The audit evolved from the issues identified. The plan included doing an audit before and after implementation of a revised worksheet. The area at the top of the revised worksheet was shaded for the patient to fill in the full name and date of birth. From the frequently occurring ICD-9 codes review, a one page handout with the common duty limiting diagnoses and ICD-9 codes was developed.

A pre-assessment audit encompassed the review of the electronic medical and PIMR records of 79 active duty airmen visiting the outpatient facility for a duty limiting condition followed by a post-assessment audit with the electronic medical records and PIMR records of 30 active duty airmen with office visits for duty limiting conditions.

The pre-worksheet audit showed a compliance of 87 percent and post new worksheet compliance of 100 percent in filling in a full name on the PIMR worksheet. The Chi Square test indicated a significant difference between pre-worksheet and post-worksheet change with p 0.05 (See Graph 1). The results reveal the worksheet assisted with obtaining complete name information.

The next measurement showed zero compliance with the listing of the date of birth of the patient. The post-worksheet audit demonstrated 87 percent compliance. The Chi Square test indicated a statistically significant change with p 0.001 (See Graph 2). The results reveal the revised worksheet assisted with obtaining date of birth information, but with a below 90 percent compliance, it could allow errors to occur.

The listing of a written diagnosis on the PIMR worksheet encompassed the subsequent indicator. The pre-worksheet audit showed 67 percent compliance and post-worksheet demonstrated 90 percent compliance. The Chi Square test indicated a significant difference between pre- and post-worksheet change with p 0.015 (See Graph 3). The findings show the revised worksheet improved the documentation of a written diagnosis.

Review of the diagnosis code in the electronic record and the PIMR database comprised the final indicator. The pre-worksheet audit showed a match of 65 percent. The post-worksheet audit revealed an agreement of 86 percent, a Chi Square difference of $p < 0.02$ (See Graph 4). The outcome shows the revised worksheet and a handout altered positively the matching of the diagnosis.

From the case reviews, an incorrect diagnosis almost resulted in a patient receiving a Continuous Positive Airway Pressure machine for sleep apnea. A closer

look at wrong codes entered into the PIMR database revealed the codes and diagnoses in Table 2.

Closely related coding showed up in the audit as non-matching ICD-9 codes as indicated in Table 3 and 4. The codes in these situations could be used interchangeably as the corresponding code in either the PIMR database or the electronic medical record involved pain in the joint or body part. Some of the codes involved injury coding without corresponding indications of injury in the electronic medical record.

The analysis of effectiveness of the initiative included comparing the results of the PIMR audits prior to implementation of a revised PIMR worksheet to the PIMR audits after implementation. All four audits uncovered improvements, but further progress toward 100 percent will continue to be pursued.

Conclusion: A Patient Safety Practice from the definition described by the Agency for Healthcare Research and Quality 2001 encompasses a structural application to reduce errors (Shojania, et al., 2001). For this Patient Safety Practice initiative on reducing patient identification and diagnosis problems occurring with duty limiting conditions, the facility employed the structural application of the Complex Adaptive System Theory (Stacey, 2007) and accomplished the first objective of the initiative.

Complex Adaptive System Theory consists of nonlinear relationships between interdependent forces in complex healthcare organizations. As Figure 1 delineated, the individuals working in the facility and the patient interact in repetitive, nonlinear fashions. The healthcare organization creates a wide-range of elements, including such factors as human behavior and communication, technological interfaces, socio-cultural factors and organizational limitations that can lead to errors. By creating a schematic, the overall process can be visualized and roles and responsibilities dissected.

Case study methodology assisted the course of action by starting with the end results of the case events and working backward to unravel the parts of the process that led to the outcome. The facility accomplished the second objective to execute change based on evidence from the analysis of the events with implementation of a revised PIMR worksheet and process for duty limiting condition visits.

The quantitative results demonstrated the effectiveness of the intervention with statistically significant increases in the information documented on the worksheet and less coding problems after the change in the PIMR worksheet. The increase in use of full name from 87 to 100 percent p 0.05 and the increase in date of birth from zero to 87 percent indicate an effective intervention.

Barriers exist to the accurate and thorough completion of the PIMR worksheet. In a busy outpatient clinic, preoccupation, interruptions or distractions increases cognitive burden and raises the risk of leaving out information on a worksheet. Future design could eliminate the manual entry of the duty limiting condition information. A latent condition or a flawed system design exists with parts of the PIMR database and the electronic medical record information on duty limiting conditions. The electronic medical record contains all the information on the

duty limiting condition required in the PIMR database. By designing a future medical record system for electronic transfer of the required information, the burden of the provider manually writing information on a worksheet and the medical technician manually entering information could be eliminated.

Figure 1. The System as an open non-linear entity with many directions of interactions and interrelationships.

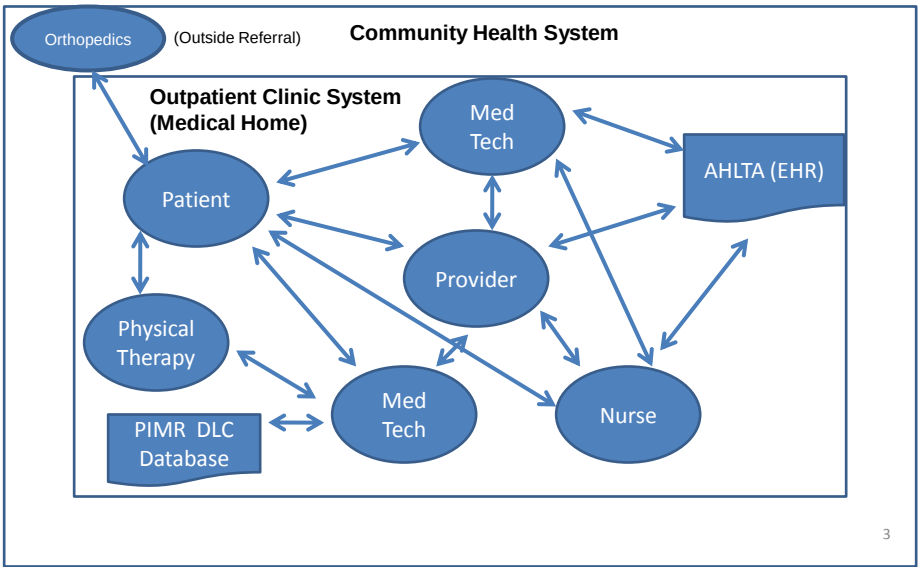
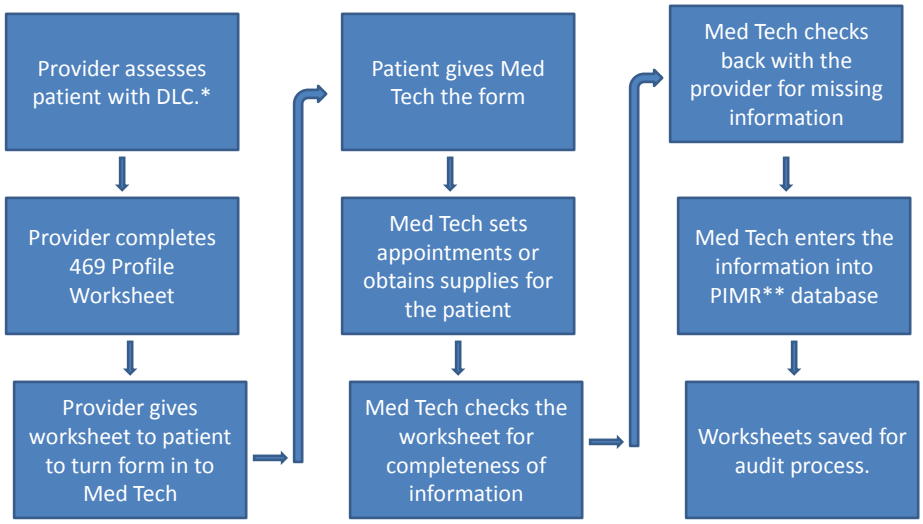


Figure 2. Flowchart of 469 Profile Process for Duty Limiting Conditions Worksheets

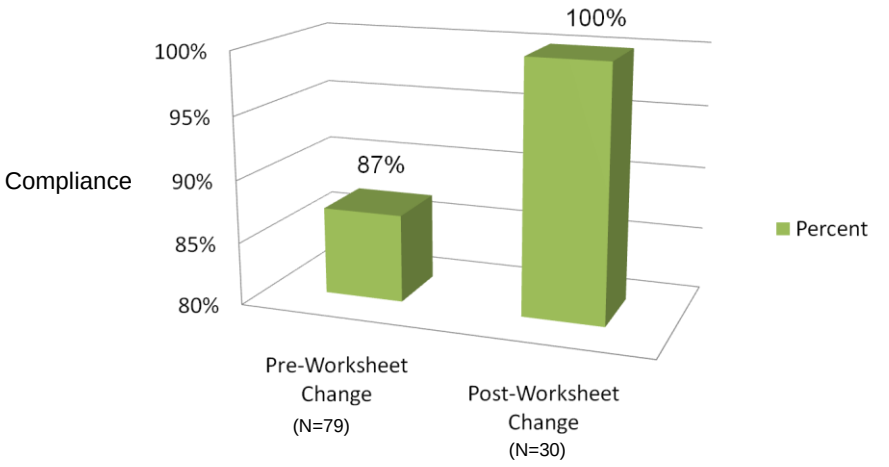


*DLC-duty limiting condition; **PIMR – Preventive Health Assessment and Individual Medical Readiness

Table 1. Worksheet issues identified from interview of key stakeholders

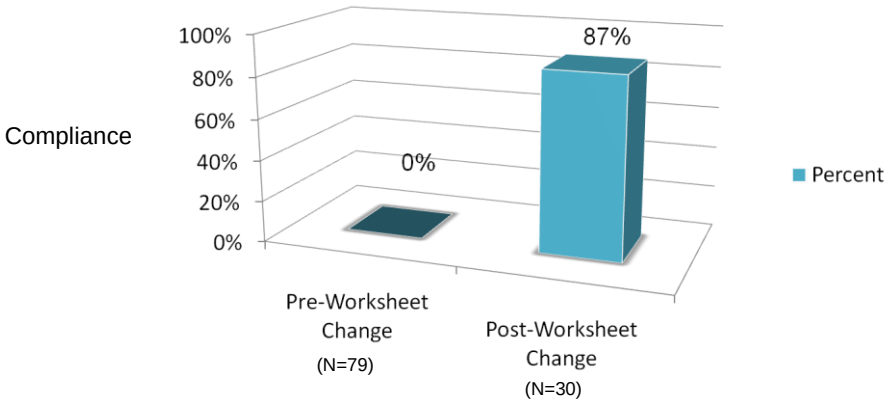
Issues with PIMR Worksheet and the Process
Patient identifier – full name not consistently used
Patient identifier – date of birth not on the worksheet
Written diagnosis not on worksheet
ICD-9 Injury codes with E codes not being consistently used at first post-injury office visit.
Time consuming process in filling out the worksheet

Graph 1. Audit of Full Name on Profile Worksheet



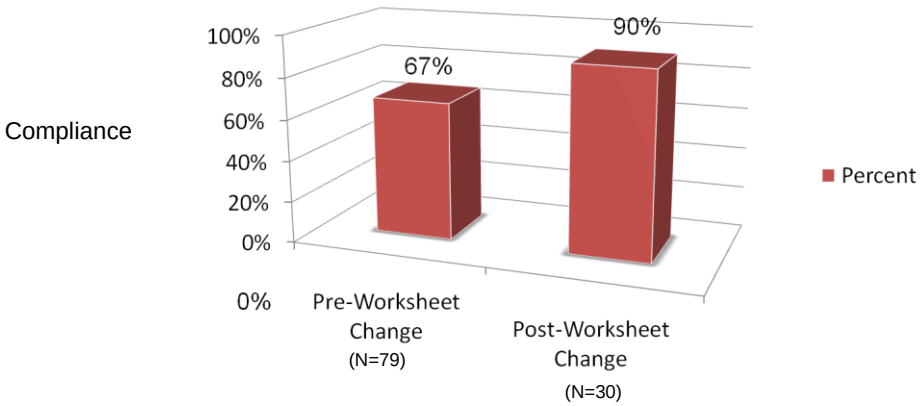
$X^2 = 3.407$ $p < 0.05$

Graph 2. Audit of date of birth – complete information on the worksheet



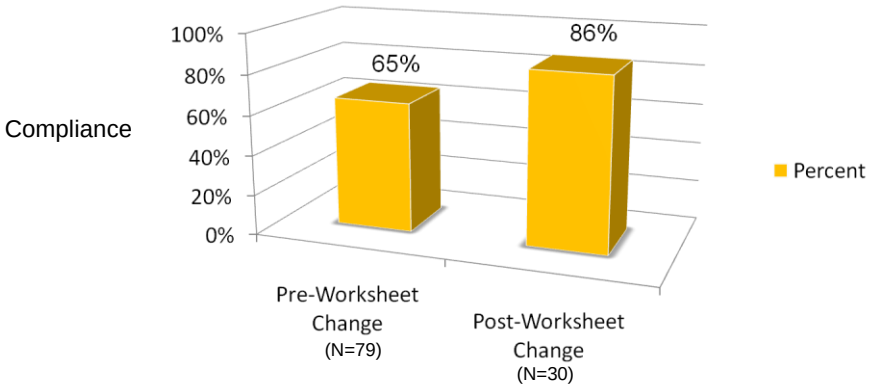
$X^2 = 48.102$ $p < 0.001$

Graph 3. Audit of written diagnosis – diagnosis documented on worksheet.



$X^2 = 3.3403 \quad p < 0.015$

Graph 4. PIMR ICD-9 entries match ICD-9 documented in the electronic health record.



$X^2 = 2.587 \quad p < 0.02$

Table 2. PIMR Audit -Wrong Codes

PIMR		Electronic Medical Record	
ICD-9	**Diagnosis**	**ICD-9**	**Diagnosis**
845.00	Ankle Sprain	844.9	Shin Splints
729.5	Pain in Limb	816.01	Acute finger fracture
844.9	Knee Sprain	840.4	Shoulder Sprain Rotator Cuff
729.5	Pain in Limb	726.71	Achilles Tendonitis
729.5	Pain in Limb	780.57	Sleep Apnea

Table 3. PIMR Audit Non-matching Codes

PIMR		Electronic Medical Record	
ICD-9	**Diagnosis**	**ICD-9**	**Diagnosis**
717.9	Internal derange knee	719.46	Patellofemoral Syndrome
729.5	Pain below knee	844.9	Shin splints
717.9	Internal derange knee	719.46	Patellofemoral Syndrome
724.8	Back muscle spasm	724.2	Lower back pain
845.09	Ankle sprain achilles	719.47	Pain in ankle/no injury noted
844.9	Knee sprain	719.46	Patellofemoral Syndrome
718.91	Joint derange shoulder	719.41	Joint pain in shoulder

Table 4. PIMR Audit: Non-matching Codes continued…

PIMR		Electronic Medical Record	
ICD-9	**Diagnosis**	**ICD-9**	**Diagnosis**
718.86	Joint instability of knee	719.46	Joint pain in knee
789.09	Groin pain	550.9	Inguinal hernia
716.87	Ankle sprain	716.97	Arthropathy ankle
729.5	Pain in limb	844.8	Leg strain peroneus longus muscle
729.5	Pain in Limb	840.4	Shoulder Sprain