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The Impact of Inpatient Electronic Sign-out on Quality and Patient Safety

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Abstract **Introduction:** The transition of patient care to the resident on call during the sign-out/hand off is an integral part of residency training and is a time vulnerable to medical errors. **Methods:** Authors conducted the study from July 28th to December 14th 2014. Residents (n=26) were required to sign-out via the electronically via the SBAR (Situation-Background-Assessment-Recommendation) based electronic template. The quality of sign-out was assessed by night float questionnaire. The quality of the sign-out (scale 1 to 5), preventable morbidities, LOS, mortalities and readmissions were compared pre and post intervention for the admitted patients (pre= 184, post=172). **Results:** Improvement in the mean quality (Likert scale 1-5) of both the written sign-out, 3.0 to 3.8 ($p<0.001$), and verbal sign-out, 3.0 to 3.6 ($p=0.002$) (n=22 pre and post), was found. The preventable morbidities decreased from 10% to 5% ($p=0.047$). No statistically significant difference was noted for lethal morbidities, length of stay or readmissions. **Conclusion:** Implementation of electronic sign-out in addition to verbal sign-out improved the quality of sign-out with trend towards reduction in morbidities. The electronic sign-out may provide key information and help the on call team to make better decisions regarding the patient care.

Keywords: *sign-out, transition of care, residency training, quality improvement, performance improvement*

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1. Introduction

Effective July 2003, the Accreditation Council of Graduate Medical Education (ACGME) implemented a nation-wide work-hour policy to restrict residents' duty hours in order to improve patient safety and clinical outcomes. This changed the traditional model of inpatient medicine where there was a primary physician was mainly responsible for inpatient care to a team based approach. [1] With this 80-hours a week work restriction (48% of weekly hours), patient care under the primary care member dropped significantly to less than half compare to 70% primary team coverage about a decade ago. The revised work hour regulations implemented in 2011, restricted an intern to a sixteen hour limit in twenty four hours. This lead to an emergence of night floats system. [2] With the new work hour regulation, there is an average three patient sign-outs between physicians happening in a twenty four hour period. This sign-out time period is susceptible for discontinuity of care. [3] It is noted that poor communication between physicians is a leading cause in the majority of sentinel events in the hospitals. [4] Additionally, miscommunication and discontinuity of care increases in-hospital complications, hospital stay, inpatient laboratory tests, and other preventable adverse events. [5] Therefore, improving hand off/sign-out is a priority nationwide and the ACGM Erequires that training programs provide formal instruction in sign-out and to monitor it within the residency training programs. [6] Additionally, Joint Commission requires that physician handoffs/sign-out should be standardized in order to facilitate continuity of care and patient safety. [5]

Effective patient sign-out refers to the transfer of information between physicians which results in better understanding of patient problems, the care goals and tasks, which in turn creates an opportunity to identify and correct errors in real time. [1] Although effective sign-out is important, many residency programs lack a formal sign-out system or proper training. [3] Effective sign-out can be achieved by training in communication skills, the use of mnemonics, minimizing interruption during the sign-out process, and use of written electronic templates. [7] Implementation of a proper sign-out program has been shown to improve outcomes including reduction in medical errors, length of stay and enhancing professionalism and communication between resident. [8] Our study prospectively analyzes the quality of sign-out and patient outcomes after the implementation of a standardized electronic sign-out.

2. Methods

2.1. Participants and Settings

From July 28th to December 14th 2014 this prospective study was conducted at Conemaugh Health System (CHS)

within the Internal Medicine program. This project was reviewed by Memorial Medical Center's Institutional Review Board and was determined to be a performance improvement project. A bench mark quality of sign-out (verbal+ written sheets) was assessed from July 28th to August 24th, 2014. A post intervention assessment of sign-out (verbal + e-handoff) was assessed from November 17th to December 14th 2014.Assessment of sign-out was performed by night float intern. Patient safety indicators were assessed pre and post intervention over one block period.

2.2. The Intervention

At our institution the sign-out occurs at two time points: 4 pm and 7 pm. At 4 pm the morning teams provides sign-out to the short call team and then at 7pm the short call team provides sign-out to the night float team. The traditional sign-out consisted of hand written notes in an unstructured format given to the short call and night float teams.

We implemented the intervention, starting August 25th, 2014. The SBAR (Situation-Background-Assessment-Recommendation) mnemonic was modified to create an electronic template. [9] The electronic template uploaded on the website (www.e-handoff.net) included following items: patient identification (Situation-S), medications, cardiac and neurological status, vitals, important laboratory values and code status (Background-B), active problems and plans (Assessment-A) and instructions to the night float team (Recommendations-R)(Appendix A). The inpatient teams were asked to update patient information electronically via e-handoff and provide verbal instructions along with printed sign-out at 4 pm and 7pm. To ensure adherence to the intervention, bi weekly compliance was assessed at random times. Compliance was calculated by comparing the e-handoff census to the automatically updated hospital census for each attending.

2.3. Assessment of Sign-out Quality and Patient Safety

The quality of sign-out was assessed by utilizing three main parameters: 1) The Post Call Night Float Questionnaire, 2) Patient Safety Indicators, and 3) The Resident Survey. The Post Call Night Float Questionnaire (See Appendix B) was administered pre and post-intervention. The face and content validity of the questionnaire was established by obtaining faculty's feedback. The night float intern was provided a brief tutorial with teach-back regarding how to accurately document medical error and rate the quality of sign-out.

The night float intern (7pm to 7 am) was queried for following aspects of sign-out: a) quality of verbal, written and overall sign-out on 5-point Likert scale, b) Preventable non-lethal morbidities occurring each night, defined as any medical error that could adversely affect patient care and could have been averted by improved patient sign-out.

Patient Safety Indicators included: a) All cause mortalities b) Lethal morbidities defined as any morbidity requiring activation of inpatient code blue or rapid response team, c) The number of re-admissions for the internal medicine service, d) The LOS for internal medicine service.

Patient homogeneity over time period was assessed by comparing patient volume, length of stay (LOS) and case mix index (CMI), a value assigned to diagnosis related group (DRG). A higher CMI correlates to a more complicated case with more comorbidities. It was used as a surrogate index to compare acuity of illness in the studied population. All data was obtained from hospital records stored and updated in the case management unit.

2.4. Statistical Analysis

The family-wise alpha of 0.05 was adjusted to 0.010 using the Bonferroni Correction for multiple outcome variables (three outcome variables and two assessing homogeneity over time). Due to violations of normality and the use of a five-point Likert scale, the Mann-Whitney U test was applied to compare the *distributions* of the pre and post responses of the written, verbal, and overall quality of the night float sign-out and resident surveys. Although the same residents were surveyed, the data was not paired and only verbal quality was correlated at the 0.05 level over time, r = 0.517.As four analyses were conducted on the night float dataset, the family-wise alpha of 0.05 was adjusted to 0.013 using the Bonferroni Correction. All p-values presented are 2-sided. Statistical analyses were performed using SPSS version 19.0(IBM SPSS Statistics for Windows, IBM Corporation, Armonk, NY).

3. Results

Study patients were sufficiently similar over time period on volume admitted at inpatient service (184 vs. 172), LOS (median = 4, p = 0.170), and CMI (1.69 vs. 1.25 p=0.54) to conclude homogeneity, see Table 1. LOS and CMI were statistically significantly correlated at the 0.01 level by time period, Pearson's r_{pre} = 0.557 and r_{post} = 0.425. The biweekly compliance was assessed to monitor implementation of the intervention. The overall compliance of ninety percent was achieved during the intervention period.

3.1. Sign-out Quality

The sign-out quality and preventable morbidities were assessed by surveying the night float intern utilizing the Post Call Night Float Questionnaire. Statistically significant improvement in the quality of both verbal sign-out, from a mean rank of 3.0 to 3.6 (p=0.002), and written sign-out, from a mean of 3.0 to 3.8 (p <0.001), was found. The improvement in the overall sign-out quality, from 2.9 to 3.7 (p <0.001), was also statistically significant. Preventable non-lethal morbidities per patient decreased from 10% to 5%, p=0.047.

3.2. Patient Safety Indices

No change, pre versus post, was observed in the average length of stay per patient (5.3 vs. 4.2 pre and post intervention p=0.17) or rate of readmission per patient (10% to 15% pre and post intervention, p = 0.32). There was a non-statistically significant reduction in the mortalities per patient in pre and post intervention groups 4% to 1% p = 0.18) No statistically significant difference was observed for lethal morbidities (3% to 5%, p = 0.59).

Table 1. Comparison of Patient Outcomes and Quality Measures Pre and Post Intervention at Conemaugh Health System from July to December 2014

	Pre-Intervention (7-28 to 8-24)	**Post-Intervention** (11-17 to 12-14)	**2-sided p-value**
Patient volume ($N_{patients}$)	184	172	NC[a]
Length of Stay			
mean (total days)	5.3 (982)	4.2 (727)	
median	4	4	0.17 [b]
SD	4.2	2.8	
Case Mix Index- mean average	1.69	1.25	0.54
ReadmissionRate	10% (34/184)	15% (25/172)	0.32[c]
MortalityRate	4% (7/184)	1% (2/172)	0.18 [c]
Lethal morbidity Rate	3% (6/184)	5% (8/172)	0.59[c]
Night Float Handoff Questionnaire ($N_{residents}$: pre = post = 22)			
Preventable non-lethal incidents & morbidities	10% (19/184)	5% (8/172)	0.047[c]
Quality of Handoff [e]	Average (Mean Rank)		
Written	3.0(15.8)	3.8(29.3)	<0.001 [d]
Verbal	3.0(17.1)	3.6(27.9)	0.002[d]
Overall	2.9 (15.4)	3.7 (29.6)	<0.001 [d]

a. NC-not calculated; statistical analysis not possible because only aggregate data was available
b. both pre & post were heteroscedastic & non-normal with slight positive skew, Median Test performed
c. Fisher's Exact Test performed
d. Mann-Whitney U Test, comparing distributions
e. Likert response, 1 - 5, larger number translates to higher quality.

4. Discussion

This prospective study evaluates the use of electronic sign-out and analyzes its impact on patient care and quality of sign-out in inpatient settings. The study showed an overall improvement in quality measures. Given the growing pace of computer technology, and increasing use of electronic medical records, the electronic sign-out has now emerged as an important tool to replace the traditional paper based sign-out. We have shown that electronic use of SBAR approach improves quality of sign-out with a trend towards reduction in medical errors.

After the ACGME work hour limitation, considerable emphasis has been placed on the patient sign-out. Patient sign-out lacking pertinent details has been linked to poor patient outcomes, medical errors and transfers to intensive care unit. [3] The Graduate Medical Training programs are now required to inculcate training of sign-out with improved monitoring. [10] Mnemonic strategies have now been adapted to standardized information transfer. These include: 1) i-PASS- introduction, patient, assessment, situation and safety concerns, 2) SBAR- (situation, background, assessment, recommendation) 3) Anticipate- administrative data, new clinical information, task, illness and contingency plan. 4) UPDATED-approach, updated data, problem, diagnosis, anticipated problem, too much information, error prone medications, and directions. These strategies have been endorsed by the American Medical Association in an effort to improve transition of care and minimize medical errors as a result of shift changes. [11]

Our results suggested that standardized electronic sign-outmay have reduced the non-life threatening medical errors at night (7pm to 7 am), while patient safety measures including lethal morbidities, length of stay or readmissions or mortality were unchanged. Standardized sign-out ensures consistency and reduces medical errors. Check list based evaluation during the perioperative period has shown to improve surgical outcomes. [12,13] Ina recent multicenter study, mnemonic strategies such as i-PASS was demonstrated to reduce medical errors. [8] The i-PASS template was integrated into electronic medical records. The rate of medical errors and preventable adverse events were evaluated as primary outcome measures. The results demonstrated a reduction in medical errors by 23 % and preventable adverse events by 30%. In a different study conducted on 27 pediatric interns mnemonic strategy ABC-SBAR improved the mean score of sign-out from 3.1/10 to 7.8/10, while increasing the duration of sign-out. That study was conducted on simulated patient scenarios. [4] In another prospective study, conducted in a pediatric cardiac intensive care unit over a three year period, medical teams were surveyed to assess information transfer, patient complications, and quality of sign-out before and after the implementation of standardized sign-out instrument. In addition, length of stay was also compared. The survey revealed that handoff instrument improved the communication among team members and minimized the loss of information. Furthermore, it reduced patient complications (metabolic acidosis p=0.004, early extubation p=0.04, and mediastinal exploration p=0.04). [14]

Our results were congruent with a report by Graham et al. [15] The study included a total of 39 interns providing sign-out over 139 shifts. The intervention consisted of electronic sign-out in addition to residency shift assortment. While the authors showed an improved quality of the sign-out process in several respects that included information and physician satisfaction, no significant difference was observed for adverse events. In another study by Gonzalo et al, [16] an electronic sign-out, the eSignout with or without verbal communication, was implemented to supplement the emergency department information on patients being admitted to the inpatient

service. The reported near misses and adverse events were similar after the implementation of eSignout. Furthermore, 93% of the residents perceived that eSignout was more efficient.

There are a few limitations of our study. We did not explore whether bedside sign-out is superior to traditional sign-out. In the U.S, patient signout is generally provided in a quiet room, hence minimizing distractions. Bedside sign-out is generally reserved for sicker population groups, e.g. patients in intensive care units. The study was conducted from August to December. Improved resident clinical experience secondary to "July phenomenon" may have contributed to a bias. [17,18] It is known that length of stay, cost, and hospitalization complications increase with the arrival of new trainees. This phenomenon may have little effect on surgical care where adequate superivion of an attending surgeon exists in the operating room. However, the supervsion on the Internal Medicine service by a faculty is available only during rounds. As interns learn over time, their clinical judgment improves, and this may have contributed to better quality scores and reduced medical errors in the post-intervention group. [19,20] We lacked objective indices for the morbidities and incidents since they were assessed by way of survey. Given that the transition of care occurred in the evening, there was scarce faculty supervision. To minimize reporting bias, we queried the residents immediately at the end of night shift to provide a more accurate account of medical errors. The fact that residents were being monitored may have introduced bias associated with the Hawthorne phenomenon. [21] This effect may have cancelled given the fact that residents were surveyed pre and post intervention. Lastly, the study may be under powered in few aspects due to limited sample size. Despite these limitations, we provide prospective analysis of the utility of SBAR based sign-out to assess patient outcomes.

5. Conclusion

In conclusion, we have shown that SBAR based electronic sign-out when utilized with face to face sign out may stream line information provided to the night shift and may reduce medical errors. It may minimize information loss during shift change. Electronic sign-out when compared to written sign-out provides a superior means of communication between the morning and the night shift.

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Previous Presentation

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Other Disclosures

None.

Ethical Approval

Upon review, the CHS Institutional Review Board determined this study to be a quality improvement project and exempt.

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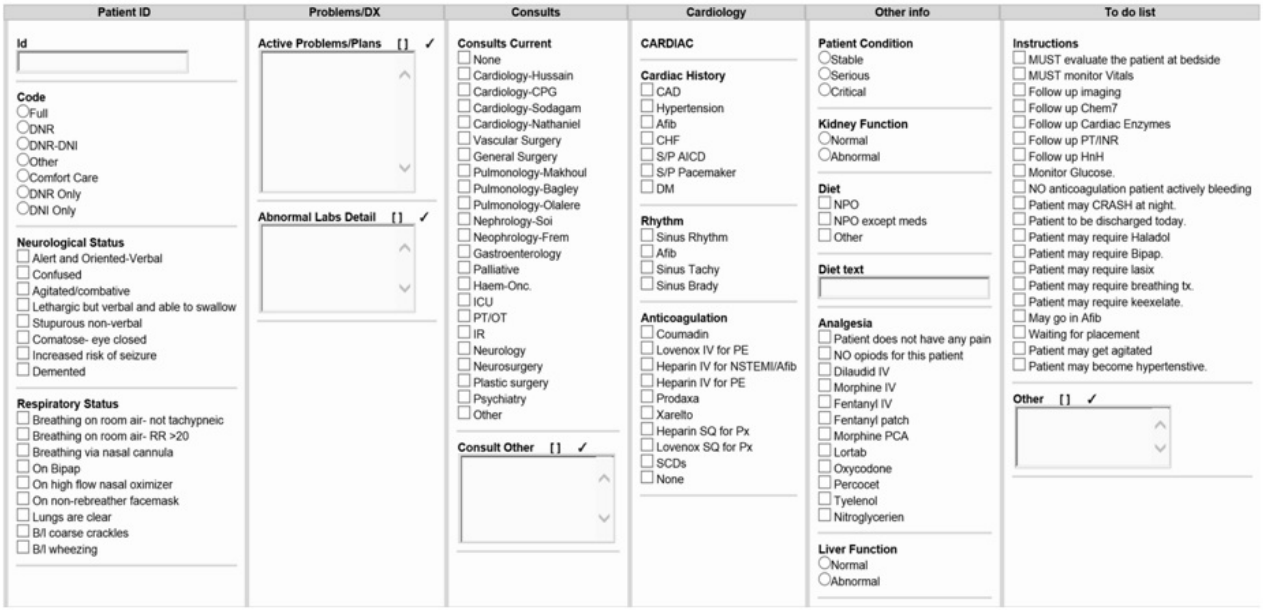
Appendix A: Electronic Template for Handoff



Patient ID

Id

Code
- ○ Full
- ○ DNR
- ○ DNR-DNI
- ○ Other
- ○ Comfort Care
- ○ DNR Only
- ○ DNI Only

Neurological Status
- ☐ Alert and Oriented-Verbal
- ☐ Confused
- ☐ Agitated/combative
- ☐ Lethargic but verbal and able to swallow
- ☐ Stupurous non-verbal
- ☐ Comatose- eye closed
- ☐ Increased risk of seizure
- ☐ Demented

Respiratory Status
- ☐ Breathing on room air- not tachypneic
- ☐ Breathing on room air- RR >20
- ☐ Breathing via nasal cannula
- ☐ On Bipap
- ☐ On high flow nasal oximizer
- ☐ On non-rebreather facemask
- ☐ Lungs are clear
- ☐ B/l coarse crackles
- ☐ B/l wheezing

Problems/DX

Active Problems/Plans [ ] ✓

Abnormal Labs Detail [ ] ✓

Consults

Consults Current
- ☐ None
- ☐ Cardiology-Hussain
- ☐ Cardiology-CPG
- ☐ Cardiology-Sodagam
- ☐ Cardiology-Nathaniel
- ☐ Vascular Surgery
- ☐ General Surgery
- ☐ Pulmonology-Makhoul
- ☐ Pulmonology-Bagley
- ☐ Pulmonology-Olalere
- ☐ Nephrology-Soi
- ☐ Neophrology-Frem
- ☐ Gastroenterology
- ☐ Palliative
- ☐ Haem-Onc.
- ☐ ICU
- ☐ PT/OT
- ☐ IR
- ☐ Neurology
- ☐ Neurosurgery
- ☐ Plastic surgery
- ☐ Psychiatry
- ☐ Other

Consult Other [ ] ✓

Cardiology

CARDIAC

Cardiac History
- ☐ CAD
- ☐ Hypertension
- ☐ Afib
- ☐ CHF
- ☐ S/P AICD
- ☐ S/P Pacemaker
- ☐ DM

Rhythm
- ☐ Sinus Rhythm
- ☐ Afib
- ☐ Sinus Tachy
- ☐ Sinus Brady

Anticoagulation
- ☐ Coumadin
- ☐ Lovenox IV for PE
- ☐ Heparin IV for NSTEMI/Afib
- ☐ Heparin IV for PE
- ☐ Prodaxa
- ☐ Xarelto
- ☐ Heparin SQ for Px
- ☐ Lovenox SQ for Px
- ☐ SCDs
- ☐ None

Other info

Patient Condition
- ○ Stable
- ○ Serious
- ○ Critical

Kidney Function
- ○ Normal
- ○ Abnormal

Diet
- ☐ NPO
- ☐ NPO except meds
- ☐ Other

Diet text

Analgesia
- ☐ Patient does not have any pain
- ☐ NO opiods for this patient
- ☐ Dilaudid IV
- ☐ Morphine IV
- ☐ Fentanyl IV
- ☐ Fentanyl patch
- ☐ Morphine PCA
- ☐ Lortab
- ☐ Oxycodone
- ☐ Percocet
- ☐ Tyelenol
- ☐ Nitroglycerien

Liver Function
- ○ Normal
- ○ Abnormal

To do list

Instructions
- ☐ MUST evaluate the patient at bedside
- ☐ MUST monitor Vitals
- ☐ Follow up imaging
- ☐ Follow up Chem7
- ☐ Follow up Cardiac Enzymes
- ☐ Follow up PT/INR
- ☐ Follow up HnH
- ☐ Monitor Glucose.
- ☐ NO anticoagulation patient actively bleeding
- ☐ Patient may CRASH at night.
- ☐ Patient to be discharged today.
- ☐ Patient may require Haladol
- ☐ Patient may require Bipap.
- ☐ Patient may require lasix
- ☐ Patient may require breathing tx.
- ☐ Patient may require keexelate.
- ☐ May go in Afib
- ☐ Waiting for placement
- ☐ Patient may get agitated
- ☐ Patient may become hypertenstive.

Other [ ] ✓

Appendix B: The Post Call Night Float Questionnaire

The Post-Call Night Float Questionnaire

1) **Can you please rate the written handoff quality that you received at 7 pm based on your nightshift experience? Please circle the number.**

Poor		Average	Above Average	Excellent
1	2	3	4	5

2) **Can you please rate the verbal handoff quality that you received at 7 pm based on your nightshift experience? Please circle the number.**

Poor		Average	Above Average	Excellent
1	2	3	4	5

3) **Can you please rate the overall handoff quality that you received at 7 pm based on your nightshift experience? Please circle the number.**

Poor		Average	Above Average	Excellent
1	2	3	4	5

How many incidents/morbidity that you recall happened overnight that could have been prevented with appropriate handoff? (Please provide a numerical figure from 0 to 50)

_____