The Impact of Adding a Physician Assistant to a Rural Community Hospital Intensive Care Unit

Donald Fung, MD; Joseph Caswell, Ph.D.; Tanya James, Vanessa Charette, BSc, Gavan Harmen, MD Kerry Reed, MD; Michael Conlon, Ph.D.

Abstract
Physician Assistants (PAs) are being used to enhance service delivery in a variety of practice settings. This study investigated the impact of adding a physician assistant to an internist team covering a rural community hospital Intensive Care Unit (ICU) in North East Ontario. Retrospective chart reviews and Canadian Institute of Health Information (CIHI) data extraction was done on a cohort of ICU patients prior to the hiring of a PA (no PA) and compared to a cohort of ICU patients who had received care from a PA during their ICU stay. Inverse probability of treatment propensity scores were applied to match a no PA cohort (n=136) to a PA cohort (n=132). Cohorts were matched to gender, age, comorbidity, and diagnostic groups. The use of a PA was associated with a trend towards lower mortality (42% vs 27%, $p<0.07$) and no difference in readmission rates or resource intensity. Post PA patients had greater lengths of ICU and hospital stay (19 hrs, $p<0.002$; 2 days, $p<0.002$) and more complete admission notes ($p<0.003$). Adding a PA was associated with greater ICU and hospital length of stay, more complete admission notes and a trend towards improved mortality.

Key Words:
Physician Assistant, Canada, Ontario, Community Care Hospital, Intensive Care Unit

Introduction

Physician assistants (PAs) are increasingly utilized in Canada and especially within Ontario (1) (2) (3). Studies from ICU and non-ICU settings over three decades have reported benefits in service delivery such as patient wait times (4) (5) (6), length of stay (7) (8), physician workload (5), patient satisfaction, patient communication (7), and patient flow (9) (6) (10), while no differences in mortality, morbidity, readmissions and length of stay (LOS) were found (6) (11) (12) (13). To our knowledge there are no published outcomes from Canadian academic or community hospital ICUs.

This study examined the impact of the addition of a physician assistant to the medical ICU team on hospital outcomes at a medium acuity ICU at a North Eastern Ontario district referral hospital. The study hospital, North Bay Regional Health Centre, is a rural 389 bed district referral hub hospital in Northeastern Ontario that serves as a catchment for a population of 150000. It has an ICU with a 16 bed capacity and has a

level 3 designation; the ICU case mix includes medical and surgical patients requiring high acuity care including advance invasive and non-invasive ventilation, vasopressor support and renal replacement therapy. It does not provide advanced surgical specialty care such as neurosurgery, cardiac, thoracic, vascular or complex orthopedic or oncological surgery nor does it provide interventional radiology or cardiology. It has the capacity for up to 8 invasively ventilated patients but averages one to two per day.

Community ICUs have traditionally had open units where physicians (family physicians or specialists) admit and remain the most responsible physician of their own patients; lead by academic centers, many ICUs have adopted a closed unit where all patients are admitted under a dedicated group of ICU specialists that cover the unit with 24/7 schedule. This model yields more consistent and sustainable coverage with greater availability and access to physician coverage. Prior to 2014, the ICU at the study hospital was an open unit model. In 2014-2015, the unit changed its coverage to a largely closed unit model where an internist provides day time coverage of all non- ventilated ICU patients for one week at a time; an on-call internist provided after hours coverage of ER, ICU and medical units.

To enable this change in practice, the internal medicine group recruited a PA to support the internist assigned to ICU coverage. A learning curriculum and medical directives were developed by the Chief of Internal Medicine that enabled the PA to assess and provide care for his/her own set of patients daily, which included the history and physical, ordering basic investigations, taking telephone orders from the MRP, initiating pre-printed orders, communicating with patients families, ICU team members, and physicians, writing daily progress notes, and dictating transfer and discharge notes from the ICU. The PA was assigned patients alongside family practice residents and medical students assigned to the ICU as part of their internal medicine rotations. The primary aim of the study was to examine the impact of a new community ICU model of care that included a PA on patient ICU and hospital mortality, ICU and inpatient length of stay, hospital readmission rate.

Methods

Research ethics approval was obtained prior to the study from the hospital research ethics board.

An observational propensity weighted case-control study design was used to examine how the addition of a PA to the internal medicine team covering the ICU of a community hospital affected mortality, readmission, ICU and hospital LOS, Hospital Intensity Group (HIG) weighting*, and quality of chart documentation. The quality of chart documentation evaluated the frequency of daily documentation as well as admission and discharge from ICU notes by any provider (addition of the PA could potentially improve overall chart documentation of all providers).

Retrospective chart reviews and CIHI data extraction was done on a pre-implementation (no PA) and post- implementation (PA) cohort of patients at a community hospital

intensive care unit in North East Ontario. Unmatched comparisons between groups demonstrated significant differences in important baseline characteristics (gender, comorbidity and type of case). Propensity score matching match patients in each cohort who share a similar value of propensity score (14); scores are generated by logistic regression analysis of baseline characteristics against probability of "treatment". Propensity scores in study was based on an Inverse Probability of Treatment Weights (IPTW) approach; the count of each patient in no PA cohort with the PA cohort was increased or decreased based on the inverse of their probability of treatment (14) (15). Outcomes in the two new cohorts were then compared for statistical significance.

*HIG weighting refers to the resource intensity weight assigned to each case based on most responsible diagnosis, comorbidities, and complications; these weights are used to determine provincial remuneration for that case to the hospital (the higher the HIG weight, the more the funding).

A matched case-control review of 268 patient ICU charts was conducted, drawn from a period before and after the addition of a PA. A convenience sample was obtained from two 12 months periods of care; a coding expert extracted from hospital CIHI system over that time period 25 patients coded with a most responsible diagnosis of congestive heart failure, exacerbation of chronic obstructive pulmonary disease, pneumonia, acute coronary syndrome/myocardial infarction, and stroke. These diagnostic groups represented our five most common ICU diagnostic groups. Charts were retrieved for 268 patients; data was missing or the chart was not obtainable for 25 charts. Complete data was obtained from 243 charts. Baseline patient characteristics were obtained age, gender, Charleston co-morbidity score (0-3); the most responsible diagnosis (all obtained from hospital CIHI database) and the creatinine difference (initial vs lowest) as a marker of severity of illness (obtained from chart reviews). Patient CIHI data yielded each patient's LOS (ICU and hospital); mortality (ICU, hospital and 30 day mortality); 30 day hospital readmission rate, and Hospital Intensity Group (HIG) scores.

Quality of documentation indicators were chosen based on documentation standards required by Ontario College of Physician and Surgeons (appendix 1). Two chart reviewers evaluated each chart for quality of documentation indicators: presence of daily progress notes; presence of an admission note: and the degree of completion of the following four documentation requirements: best medication admission list (BMAL), best medication transfer list score (BMTL), resuscitation plan; and VTE orders completion. The last four indicators were combined into a composite documentation quality score. Chart reviewers validated the inter-rater reliability of the chart audit tool on 10 charts prior to data collection. The chart audit tool was completed by both reviewers independently on 10 charts and inter-reliability of the tool yielded a Kappa of 0.8 (indicating good reliability between raters and adequate to make comparisons).

Descriptive statistics and frequencies along with standardized differences (d = difference divided by standard deviation) were calculated for all covariates before and after weighting (table 1). Standardized differences exceeded 10% in case type (MI and stroke), sex, and

comorbidity scores between PA and no PA groups (table 1 before IPTW) indicating significant mismatching of the two groups. Inverse probability of treatment weights (IPTW) that counted each individual on their inverse probability of treatment resulted in substantially better matched cohorts (table 1 after IPTW). Outcome variables were summarized and analyzed before and after weighting.

For preliminary un-weighted analyses, chi-square tests were used for categorical outcomes. This was substituted for Fisher's exact test for any analyses with sample size less than or equal to 5. For comparison of continuous outcome variables two-sample Wilcoxon test was employed to compare mean rank differences.

For analyses using IPTW, weighted chi-square tests were used for categorical outcomes. In order to test for differences among continuous outcomes quantile regression was used to accommodate weighted median tests

All analyses were performed using SAS v9.4. Results were considered statistically significant where $p < 0.05$.

Results

Two chart reviewers collected data from the charts of 268 ICU patients (n=136 no PA; n=132 PA). There was substantial differences between patients between cohorts (d > 10%) in terms of gender, in comorbidity classes 1, 3 and 4, and in numbers in diagnostic groups (MI and stroke) (table 1, before IPTW). Logistic regression analysis of patient characteristics was applied to determine probability of "treatment" (PA vs no PA) and these probabilities were used to adjust the weighting of each patient in each sample. This resulted in more equal composition in both cohorts; d<10% in all characteristics (table 1, post IPTW).

Comparison of the outcomes between the matched PA and no PA cohorts (table 2, post IPTW) revealed significant differences in hospital length of stay (PA median 7; no PA 5 days, p<0.002) and ICU length of stay (PA 69 hours; no PA 48 hours, p<0.002). There was also a significant difference in the quality of the admission note in the PA group (PA score <0.5 28.65%; no PA score< 0.5 56.15%, p<0.003). This quality reflected both admission note being present, score= 1, and a further 1.0 if it included a family history (0.5) and listed meds/allergies (0.5).

There was a trend towards lower 30 day mortality (PA 26.85; no PA 42.03, p <0.07) and towards less poor quality best medication transfer list (BMTL) scores (PA 80.19%; no PA 99.2%, p<0.08). There were no significant differences in hospital readmission (PA 35.06; no PA 42.29, p=0.46) and hospital intensity grouping (HIG) (PA 2.21; no PA 2.17, p=0.60), or other documentation indicators such as progress notes (PA 100%; no PA 100%, p=0.99).

Discussion

Physician assistants have been implemented increasingly to address physician workload and manpower issues and can consistently improve service delivery without compromising outcomes (7) (13) (2) (16) (1). Adding a PA to a US Level 1 Trauma service reduced surgical wait time and service LOS (8). A study conducted in Ontario demonstrated a 30.3% decrease in emergency room length of stay (LOS) after the implementation of PAs (4). PAs on an infectious disease service at an Ontario community hospital was associated with a significant decrease in the LOS and reduced time to consultation was demonstrated (17). Furthermore, the addition of PAs to a Canadian orthopedic service lead to cost efficiencies and greater service volumes (5).

This study reports on outcomes associated with the addition of a physician assistant into the 16 bed ICU of a medium size rural community hospital in North East Ontario. The addition of a PA also changed a traditional internist who serves as the most responsible physician (MRP) for their own patients from admission to discharge to one where a dedicated internist was assigned weekly to look after all CCU patients admitted to medicine who oversaw a team of at least the PA plus one or two family practice residents. That model of care allowed more consistent twice daily rounds, more continuity of care, and more immediate response to daytime issues.

An observational cohort analysis of a no PA group of patients was used to compare to a PA group each of which had a convenience sample of patients in five diagnostic groups. The two cohorts were well matched after propensity score weighting.

After propensity matching, a trend to lower mortality was found in the PA group as compared to the no PA group. There was no significant difference in readmission rates, however there was a significantly higher median hospital stay (2 days) and ICU stay (21 hours) in a PA model of care than before a PA was present. Kawar et al also used propensity matching to compare two MICUs at their center (that differed in using PAs vs resident staff) (18) . They reported no significant differences in mortality or outcomes and an increase in ICU LOS before but not after matching.

It was hypothesized in this study that the PA patient group would have a reduced length of stay due to more timely assessments. The increased length of stay could be attributed to more detailed, timely and comprehensive assessments that occur in a PA supported team model of care and an increased ability and willingness to address all patient issues prior to discharge. However, other potential causes such as late diagnoses, slower effectiveness of treatment, or a greater threshold to discharge patients may also contribute to the increased length of stay. Further research would be needed to confirm and evaluate the causes for an increased length of stay in a PA supported model of care.

A significant difference in the quality of admission note and a trend toward better completion of transfer notes was also determined for the Post PA group. It had been expected that other benefits in quality of documentation would occur given the longer, more comprehensive and more timely notes generated in a new team model of care (with dedicated PAs, attending physicians and residents). Indicators used to capture additional

documentation benefits may have lacked the sensitivity to do so. For example, lack of difference in presence of resuscitation plan, venous thromboembolism (VTE), and Best Medication Admission list completion suggest that these steps in care are done to a high degree already and that a change in model of care did not improve it further.

There was no difference in resource intensity (HIG weights). Higher HIG weights reflect greater complexity of care (and better remuneration for the hospital); no difference supports that both matched cohorts were comparable in terms of resource needs and there is no inherent difference in resources needed nor improved hospital funding as a result of the physician assistant.

The most important limitation of the study is that it does not compare the value of a PA in isolation but rather the change to a model of care from open to closed that includes a PA in the closed model. Isolating the value of a PA would be difficult to do so in an observational study design; rather the intent of the study was to examine the impact of a PA to an ICU unit as part of a change to a closed unit model of care enabled by the addition of a PA. Knowing the impact of such a change could be of value to other community ICUs who are interested in changing models of physician coverage.

Other limitations include a retrospective design, convenience sampling, before after cohort sampling approach, lack of blinding, and generalizability only to medical ICUs of rural community hospitals. A study strength was the use of propensity scoring and inverse probability weighting of cohorts which achieved better matching subjects before comparing outcomes between cohorts; this had not been done with any previous study of outcomes in centers examining the impact of Physician Assistants.

In summary, the addition of a physician assistant to a community hospital ICU team resulted in a trend towards lower 30 day mortality, and significantly increased CCU and hospital length of stays and an improvement in some quality of documentation measures. Further studies would be helpful in other centers in order to confirm these findings.

References

1. Dies, Natalie (2019) Ontario Physician Assistants. Can Fam Physician, Vol. 65(4), pp. 243-345.
2. Frechette D, Shrichand A. (2016) Insights into the physician assistant program in Canada. JAAPA, Vol. 29 (7), pp. 35-39.
3. IW, Jones. (2012) Where the Canadian physician assistants are in 2012? JAAP, Vol. 25, pp. e54-e57.
4. Ducharme J, Alder R, Pelletier C, Murray D, Tepper J. (2009) The impact on patient flow after the integration of nurse practitioners and physician assistants in six Ontario emergency departments. CMEJ, Vol. 11, pp. 455-461.
5. Bohm ER, Dunbar M, Pitman D, Rhule C, Areneta J. (2010) Experience with physician assistants in a Canadian arthroplasty program. CanJSurg, Vol. 53 (2) pp.103-8.

6. Gershengorn HB, Xu Y, Chan C, Mor A, Gong M. (2016) The impact of adding a physician assistant to a critical care outreach team. PloS One, Vol. 11(12), pp. 1-14.
7. Klienpell RM, Ely W, Grabenfort R. (2008) Nurse practitioners and physician assistants in the intensive care unit: an evidence-based review. Critical Care Medicine, Vol. 36 (10) pp. 2888-2897.
8. Hiza EA, Gottschalk MB, Umpierrez E, Bush P, Reisman WM. (2015) Effect of a dedicated orthopaedic advanced practice porvider in level 1 trauma center. J Orthop Trauma, Vol. 29 (7), pp. e225-e230.
9. Hamilton GM, Decloe M. (2011) Reviewing the evidence for Canada's physician assistant initiative. University of Toronto Medical Journal, s.1 88, pp. 88-90.
10. Messing J, Garces-King J, Taylor D, Van Horn J, Sarani B, Christmas B et.al. (2016) Optimizing the integration of advanced practitioners in trauma and critical care. J Trauma Acute Care Surg, Vol. 83 (1) pp. 190-196.
11. Costa DK, Wallace DJ, Barnato AE, Kahn J. (2014) Nurse practitioner/physician assistant staffing and critical care mortality. Chest, Vol. 146(6), pp. 1566-1573.
12. Garland A, Gershengorn HB.(2013) Staffing in ICUs: physicians and alternate staffing models. Chest, Vol. 143(1), pp. 214-221.
13. Gershengorn HB, Wunsch H, WahabR, Leaf D, Brodie D, Li G et. al. (2011) Impact of non-physician staffing on outcomes in a medical ICU. Chest, Vol. 139 (6) pp. 1347-1353.
14. Austin, PC. (2011) An introduction to propensity score methods for reducing the effects of confounding in observational studies. Multivariate Behavioral Research, Vol. 46(3), pp. 399-424.
15. Austin, PC. 2015, Moving towards best practice when using inverse probability of treatment weighting (IPTW) using a proprensity score to estimate causal treatment effects in observational studies. Statistics in Medicine, Vol. 34, pp. 3661-3679.
16. Matsushima K, Inaba K, Skiada D, Esparza M, Cho J, Lee T, et. al. (2016) A high-volume trauma intensive care unit can be successfully staffed by advanced practitioners at night. Journal of Critical Care, Vol. 33(4), pp. 1-11.
17. Decloe M, McReady J, Downey,J, Powis J. (2015) Improving health care efficiencuy through the integration of a physician assistant into an infectious disease consult service at a large urban community hospital. Can J Infect Dis Med Microbiology, Vol. 26(3), pp. 130-32.
18. Kawar, E, DiGiovine B. (2011) MICU care delivered by PAs vs Residents:do PAs measure up. JAAPA, Vol. 24, pp. 36-41.

Tables

Table 1. Covariate descriptive statistics and frequencies with standardized differences (*d*) both before and after weighting with inverse probability of treatment weights (IPTW)

	Before IPTW			After IPTW		
Baseline Characteristics (Covariates)	No PA n = 136	PA n = 132	*d*%	No PA n = 271.28	PA n = 262.67	*d*%
Case Type – n (%)						
Congestive Heart Failure (CHF)	33 (24.26)	30 (22.73)	3.63	69.99 (25.80)	65.76 (25.03)	1.76
Chronic Obstructive Pulmonary Disease (COPD)	38 (27.94)	39 (29.55)	3.55	70.95 (26.15)	69.48 (26.45)	0.68
Myocardial Infarction (MI)	30 (22.06)	36 (27.27)	12.12	69.04 (25.45)	68.79 (26.19)	1.69
Pneumonia	11 (8.09)	9 (6.82)	4.84	18.08 (6.66)	16.34 (6.22)	1.81
Stroke	24 (17.65)	18 (13.64)	11.06	43.23 (15.94)	42.30 (16.10)	0.46
Male – n (%)	86 (63.24)	76 (57.58)	11.59	162.57 (59.93)	155.29 (59.12)	1.64
Charlson Comorbidity Index – n (%)						
0	51 (37.50)	27 (20.45)	38.26	76.90 (28.35)	71.42 (27.19)	2.59
1	22 (16.18)	18 (13.64)	7.14	40.24 (14.83)	39.68 (15.11)	0.77
2	31 (22.79)	21 (15.91)	17.50	52.94 (19.51)	52.66 (20.02)	1.35
3-4	32 (23.53)	66 (50.0)	57.09	101.21 (37.31)	98.91 (37.66)	0.72
Age in Years – mean ±SD	70.65 ±11.45	70.40 ±14.67	1.87	70.42 ±16.09	70.26 ±20.91	0.86
Initial Lowest Creatinine (mml/l) – median (IQR)	9.0 (0.0-24.0)	10.50 (0.0-29.50)	7.96*	9.0 (0.0-27.0)	9.0 (0.0-27.0)	3.51*

d% = standardized difference expressed as a percentage, SD = standard deviation, IQR = interquartile range, * = *d*% was calculated using mean rank scores rather than raw values due to non-normal distribution (note that median and IQR are identical after weighting)

Table 2. Outcome descriptive statistics and frequencies with probabilities (*p*) for differences; $p < 0.05$ indicates a statistically significant difference between groups

	Before IPTW			After IPTW		
Outcomes	**No PA**	**PA**	***p***	**No PA**	**PA**	***P***
CLINICAL						
30 Day Mortality – n (%)	14 (10.29)	17 (12.88)	0.51	42.03 (15.49)	26.85 (10.22)	0.07
30 Day Readmission – n (%)	23 (16.91)	17 (12.88)	0.35	42.29 (15.59)	35.06 (13.35)	0.46
Dialysis – n (%)	4 (2.94)	4 (3.03)	>0.99	9.82 (3.62)	5.70 (2.17)	0.32
Intubation/Ventilation – n (%)	3 (2.21)	3 (2.27)	>0.99	9.96 (3.67)	4.43 (1.68)	0.16
VTE Prophylaxis Addressed – n (%)	113 (83.09)	111 (84.09)	0.83	225.04 (82.96)	217.57 (82.83)	0.97
LENGTH OF STAY						
Length of Stay (Days) – median (IQR)	5.0 (3.0-10.0)	7.0 (4.0-10.0)	0.06	5.0 (3.0-10.0)	7.0 (4.0-10.0)	0.002
ICU Length of Stay (hours) – median (IQR)	46.0 (28.0-74.50)	70.0 (46.50-99.50)	< 0.0001	48.0 (24.0-75.0)	69.0 (43.0-98.0)	0.002
ER to ICU Time (hours) – median (IQR)	1.74 (1.01-2.53)	1.83 (1.22-1.83)	0.11	1.73 (1.0-2.48)	1.85 (1.25-3.10)	0.56
ALC Days – median (IQR)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.39	0.0 (0.0-0.0)	0.0 (0.0-0.0)	>0.99
DOCUMENTATION						
Admission Note Score – n (%)			0.03			0.003
< 0.50	29 (21.32)	15 (11.36)		56.15 (20.70)	28.65 (10.91)	
0.50-1.50	53 (38.97)	69 (52.27)		110.06 (40.57)	136.34 (51.91)	
2	54	48		105.08	97.68	

	(39.71)	(36.36)		(38.73)	(37.19)	
BPMTL (at transfer) Score – n (%)			0.43			0.08
0	43 (31.62)	39 (29.55)		99.25 (36.59)	80.19 (30.53)	
0.20	3 (2.21)	7 (5.30)		4.47 (1.65)	11.60 (4.42)	
1	90 (66.18)	86 (65.15)		167.57 (61.77)	170.87 (65.05)	
Resuscitation Order Completion – n (%)			0.71			0.77
0	26 (19.12)	21 (15.91)		46.73 (17.22)	44.65 (17.0)	
0.50-0.80	13 (9.56)	11 (8.33)		24.89 (9.18)	19.69 (7.50)	
1	97 (71.32)	100 (75.76)		199.67 (73.60)	198.32 (75.50)	
Progress Notes – median (IQR) missing n = 6	100.0 (100-100)	100.0 (100-100)	0.64	100.0 (100-100)	100.0 (100-100)	>0.99
BPMH (at admission) score – median (IQR)	1.0 (0.90-1.0)	1.0 (0.90-1.0)	0.02	1.0 (0.90-1.0)	1.0 (0.90-1.0)	>0.99
Combined documentation score – median (IQR)	3.0 (2.90-3.90)	3.15 (2.90-4.0)	0.29	3.0 (2.90-3.90)	3.0 (2.90-4.0)	>0.99
BPMH (at admission) score – median (IQR)	1.0 (0.90-1.0)	1.0 (0.90-1.0)	0.02	1.0 (0.90-1.0)	1.0 (0.90-1.0)	>0.99
Combined documentation score – median (IQR)	3.0 (2.90-3.90)	3.15 (2.90-4.0)	0.29	3.0 (2.90-3.90)	3.0 (2.90-4.0)	>0.99
HIG WEIGHTS						
HIG Weight – median (IQR)	2.17 (1.70-2.41)	2.24 (1.72-2.45)	0.33	2.17 (1.70-2.47)	2.21 (1.72-2.41)	0.60

p = probability, IQR = interquartile range

Appendix 1:

Quality of documentation indicators:

- presence of daily progress notes (observed/expected*100)
- admission note: 1 for having family/social history; and 0.5 each for medication and allergies (max score =2) ;
- best medication admission list (BMHL) on admission score signed 0.4; medications 0.4; allergies noted 0.1, alternate source 0.1) (max score = 1) ;
- best medication transfer list score (BMTL) signed and completed = 1; signed only = 0.2; neither signed nor completed = 0 (max score = 1) ;
- resuscitation status form signed = 0.5; declared resuscitation status = 0.3; specified exceptions = 0.2 (max score = 1) .
- VTE orders on admission = 1 if present (max score =1).
- composite quality of documentation (BMHL+BMTL+resuscitation score+VTE (max score =4)

Appendix 2

Abbreviations used:

PA	physician assistant
ICU	intensive care unit
CIHI	Canadian Institute of Health Information
LOS	Length of Stay
HIG	Hospital Intensity Grouping
IPTW	Inverse Probability Treatment Weight
BMAL	Best Medication Admission List
BMTL	Best Medication Transfer List
MRP	most responsible physician
VTE	venous thromboembolism