

## The Contributions of Nursing and Support Staff to Patient Satisfaction Outcomes: A Production Function Approach to Determining Optimal Staffing

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### BACKGROUND

The relationship between nurse staffing and patient outcomes has long been established in the nursing literature.<sup>1,2,3</sup> As a result of this body of work, many states have either mandated staffing ratios or made public reporting or staffing committee a requirement. The literature has now expanded its initial focus on overall nursing staffing levels to include support personnel and their relationship to patient outcomes.<sup>4,5,6</sup> In this study we investigate the overall and relative impacts of registered nurses (RNs) and licensed practical nurses (LPNs), on the one hand, and nursing assistive personnel (AP) on the other, on six different measures of patient satisfaction outcomes. In addition to contributing to the nurse staffing literature, the purpose of the study was to develop a methodological approach that could be further adapted for use with different types of workers, different outcomes in different organizational settings.

### METHODS

We used data from the American Hospital Association (AHA) Annual Survey and the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey to construct a dataset that covers 1675 hospitals in 48 states for the years 2010-2014. Our dataset includes information for 1,180 urban and 495 rural hospitals and 79 major teaching and 1,596 non-teaching hospitals. To establish the impact of nurse and support staff staffing levels on patient satisfaction outcomes, we conducted multivariate regression analyses to assess the impact of RNs and LPNs hours and AP hours on the following six patient satisfaction measures from HCAHPS: Hcomp-c: the percentage of patients who reported that their room was 'always' clean, Hcomp-1: percentage of patients who reported that their nurses 'always' communicated well, Hcomp-3: the percentage of patients who reported that they 'always' received help as soon as they wanted, Hcomp-4: percentage of patients who reported that their pain was 'always' well-controlled, Hcomp-5: percentage of patients who reported that staff "always" explained about medicines prior to received them, Hcomp-6: percentage of patients who reported that hospital staff "always" gave them information about what to do during recovery at home. For each patient satisfaction measure, we conducted the following regression.

In the below regression,  $Y_{it}$  represents each patient measure for hospital  $i$  in year  $t$ . The terms LRNs measures the number of RN/LPN nurse hours per adjusted patient day and the term APs measures the number of AP hours per adjusted patient day. We include the square and cubic terms of each nursing input variable to capture potential non-linear relationships between the study's staff input and outcome measures, and an interaction term in order account for complementarity or substitutability between both types of staff inputs. Finally, we also include state and year dummies and control for each hospital's total

### KEY FINDINGS

1. This study offers a new approach for assessing optimal and minimum staffing levels for two types of health workers (nurses and assistive personnel) in relation to specific outcomes (patient satisfaction).
2. All hospitals, but especially rural, non-teaching and governmental non-federal hospitals, could increase Medicare payments based on HCAHPS scores if they increased nurse and assistive personnel staffing levels.
3. While nurse staffing is most important for satisfaction measures related to communication of medical information to patients, assistive personnel staffing also contribute to this domain, suggesting that when assistive personnel staffing is too low, it may diminish nurses' ability to conduct their clinical work.

number of FTEs, urban/rural status and teaching status through the term  $X_{it}$ . Using the regression model above, we can estimate not only the impact of RN/LPN and AP hours per adjusted patient day, but also, importantly, the optimal level of each nurse input. Optimality is determined by the level at which the marginal impact of each nursing input starts to decline. We also estimate the minimal threshold, below which variations in staffing matter little.

$$Y_{it} = \beta_1 + \beta_2 LRNhs_{it} + \beta_3 LRNhs_{it}^2 + \beta_4 LRNhs_{it}^3 + \beta_5 APhs_{it} + \beta_6 APhs_{it}^2 + \beta_7 APhs_{it}^3 + \beta_8 (LRNhs_{it})(APhs_{it}) + \beta_9 X_{it} + \varepsilon_{it}$$

## FINDINGS

We find that the number of hours per patient day of both RN/LPN and AP hospital staff are strongly related to all six patient satisfaction measures (Table 1), and that marginal products of both types of staff inputs exhibit initial increasing marginal returns, followed by decreasing marginal return. Table 2 shows the optimal level of RN/LPN and AP hours per adjusted patient day for each patient satisfaction measure ranging from 12.4 (hcomp-6), to 14.8 (hcomp-5). For AP hours per adjusted patient day, values range from 3.82 (hcomp-3) to 4.8 (hcomp-4). Considering that in our sample the average number of RN/LPN hours per adjusted patient day is 7.91, and for APs is 1.73, our findings suggest that hospitals would need to increase their number of both RN/LPN and AP nursing hours to maximize the marginal contributions to patient satisfaction outcomes from these two types of nurse inputs. Table 3 shows the percent of hospitals by type that are below the minimum threshold level of RN/LPN and AP hours per adjusted patient day at which the marginal effect of an extra hour becomes positive. The need to increase staffing levels is greatest for rural, non-teaching and governmental non-federal hospitals.

## CONCLUSION AND POLICY IMPLICATIONS

In recent years patient satisfaction has gained importance as HCAHPS scores now determine a portion of hospitals' Medicare payments. Our analysis shows that all hospitals would benefit from an increase in their nurse and AP staffing, even if they are already at a relatively high levels compared to their peers. We find that, as might be expected, the marginal contributions of staff hours per adjusted patient day for APs is greatest in the first two measures that are non-clinical domains (increasing the percentage of patients that reported that their room was 'always' clean and that they 'always' received help as soon as they wanted), while RN/LPNs contribute most to clinical domains ('always' received help as soon as they wanted and that reported that staff "always" explained about medicines prior to providing them). These findings suggest that investing in APs versus RN/LPN hours may have differing effects depending on the specific patient satisfaction measure being considered. Interestingly, however, increasing AP hours also improves clinically-related measures, albeit not as much as RN/LPN hours. This may suggest that when AP staffing is too low, RNs' ability to provide critical clinical services may be affected.

## References:

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**Table #1: Marginal Contribution to Patient Satisfaction Outcomes at Different Levels of RN-LPN and AP Hours per Adjusted Patient Day**

	RN-LPN & AP Hours Summary Statistics	(1) HCOMP_C (room cleanliness)	(2) HCOMP_1 (communication)	(3) HCOMP_3 (promptness of help)	(4) HCOMP_4 (pain control)	(5) HCOMP_5 (medicines information)	(6) HCOMP_6 (recovery information)
RN-LPN Hours per Adjusted Patient Day	Mean= 7.91	0.305***	0.407***	0.581***	0.331***	0.346***	0.346***
	75 <sup>th</sup> percentile = 9.22	0.574***	0.601***	0.947***	0.467***	0.572***	0.409***
	90 <sup>th</sup> percentile= 11.31	0.876***	0.812***	1.357***	0.623***	0.836***	0.465***
AP Hours per Adjusted Patient Day	Mean= 1.73	0.100	-0.160	-0.074	-0.180**	-0.183*	-0.253***
	75 <sup>th</sup> percentile= 2.26	0.430***	0.077	0.565***	0.037	0.081	-0.120
	90 <sup>th</sup> percentile= 3.12	0.732***	0.342***	1.176***	0.308**	0.385**	0.0406

standard errors estimated using delta method; p-values \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Table #2: Number of Hours at Which the Marginal Contribution of RN-LPN and AP Hours is Maximized**

	(1) HCOMP_C (room cleanliness)	(2) HCOMP_1 (communication)	(3) HCOMP_3 (promptness of help)	(4) HCOMP_4 (pain control)	(5) HCOMP_5 (medicines information)	(6) HCOMP_6 (recovery information)
RN-LPN Hours per Adjusted Patient Day	14.464	13.914	14.401	14.391	14.850	12.466
AP Hours per Adjusted Patient Day	3.814	4.298	3.827	4.842	4.456	4.508

The lowest necessary thresholds of RNs-LPN hours and AP hours are defined as the levels at which the marginal effect of an extra nurse hour is the greatest. When calculating the optimal level of RN-LPN hours per patient day we hold AP hours constant at its average (1.73). When calculating the optimal level of AP hours per patient day, we hold RN-LPN hours constant at its average (7.91)

**Table #3: Minimum Threshold Level of RN-LPN and AP Hours per Adjusted Patient Day and Percentage of Hospitals below each Threshold**

	(1) HCOMP_C (room cleanliness)	(2) HCOMP_1 (communication)	(3) HCOMP_3 (promptness of help)	(4) HCOMP_4 (pain control)	(5) HCOMP_5 (medicines information)	(6) HCOMP_6 (recovery information)
RN-LPN Hours per Adjusted Patient Day	6.964	6.143	6.576	5.824	6.566	4.013
<b>% hospitals above threshold</b>						
<b>Total</b>	40%	27%	34%	22%	34%	5%
Urban	36%	22%	29%	17%	29%	2%
Rural	51%	37%	44%	33%	44%	11%
Major Teaching	17%	5%	12%	4%	11%	1%
Minor Teaching	34%	20%	27%	15%	27%	1%
Non-Teaching	43%	30%	37%	26%	37%	7%
For-Profit	35%	22%	28%	17%	28%	3%
Not-For-Profit	41%	28%	35%	22%	35%	5%
Governmental non-Federal	47%	35%	43%	32%	42%	11%
AP Hours per Adjusted Patient Day	1.634	2.047	1.798	2.142	2.052	2.853
<b>% hospitals above threshold</b>						
Total	54%	69%	60%	72%	69%	87%
Urban	51%	67%	58%	70%	67%	86%
Rural	60%	73%	66%	75%	73%	87%
Major Teaching	38%	53%	43%	58%	53%	82%
Minor Teaching	49%	67%	56%	71%	67%	88%
Non-Teaching	56%	70%	62%	72%	70%	86%
For-Profit	55%	70%	62%	73%	70%	85%
Not-For-Profit	54%	69%	60%	73%	70%	88%
Governmental non-Federal	50%	63%	55%	66%	63%	83%
<p>The critical minimum level of RNs-LPN hours and AP hours per adjusted patient days is defined as the level at which the marginal contribution of an extra nurse hour becomes positive. When calculating this critical minimum level of RN-LPN hour per adjusted patient day, we hold AP hours constant at its sample average (1.73). When calculating the critical minimum level of AP hours per adjusted patient day, we hold RN-LPN hours constant at its sample average (7.91)</p>						

**Table #4:** Full Regression Results: Relationship between AP and RN-LPN nurse hours per patient day and six patient satisfactions measures from HCAHPS

	(1) HCOMP_C (room cleanliness)	(2) HCOMP_1 (communication)	(3) HCOMP_3 (promptness of help)	(4) HCOMP_4 (pain control)	(5) HCOMP_5 (medicines information)	(6) HCOMP_6 (recovery information)
RN-LPN Hours per Adjusted Patient Day	-2.973*** (0.000)	-2.029*** (0.000)	-3.915*** (0.000)	-1.301*** (0.000)	-2.280*** (0.000)	-0.554*** (0.001)
Square (RN/LNP Hour per Adj. Pat Day)	0.289*** (0.000)	0.216*** (0.000)	0.397*** (0.000)	0.143*** (0.000)	0.228*** (0.000)	0.083*** (0.000)
Cubic (RN/LNP Hour per Adj. Pat Day)	-0.007*** (0.000)	-0.005*** (0.000)	-0.009*** (0.000)	-0.003*** (0.000)	-0.005*** (0.000)	-0.002*** (0.000)
AP Hours per Adjusted Patient Day	-1.666*** (0.000)	-1.323*** (0.000)	-3.525*** (0.000)	-1.181*** (0.001)	-1.445*** (0.000)	-0.902*** (0.001)
Square (AP Hours per Adj. Pat Day)	0.796*** (0.000)	0.484*** (0.000)	1.471*** (0.000)	0.387*** (0.002)	0.528*** (0.000)	0.236** (0.015)
Cubic (AP Hours per Adj. Pat Day)	-0.070*** (0.000)	-0.038*** (0.005)	-0.128*** (0.000)	-0.027* (0.055)	-0.039** (0.016)	-0.017 (0.104)
Interaction (RN-LPN & AP Hours)	-0.048** (0.033)	-0.024 (0.151)	-0.066*** (0.008)	-0.014 (0.417)	-0.028 (0.160)	-0.002 (0.858)
Urban Hospital	-3.318*** (0.000)	-1.506*** (0.000)	-3.881*** (0.000)	-0.953*** (0.000)	-1.914*** (0.000)	-0.020 (0.861)
Major Teaching Hospital	-1.798*** (0.000)	-0.873*** (0.004)	-1.016** (0.027)	-0.848*** (0.007)	0.068 (0.853)	-0.780*** (0.001)
Total FTE Personnel	-0.001*** (0.000)	-0.000*** (0.000)	-0.001*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000** (0.022)
Governmental, non-Federal	3.549*** (0.000)	2.364*** (0.000)	2.886*** (0.000)	0.878*** (0.000)	1.881*** (0.000)	0.202 (0.297)
Not-for-Profit Hospital	3.065*** (0.000)	2.718*** (0.000)	3.191*** (0.000)	1.614*** (0.000)	2.272*** (0.000)	1.018*** (0.000)
Constant	81.543*** (0.000)	79.637*** (0.000)	75.741*** (0.000)	71.012*** (0.000)	68.385*** (0.000)	85.022*** (0.000)
Observations	6,078	6,078	6,077	6,076	6,072	6,078
R-squared	0.321	0.340	0.391	0.207	0.298	0.338

year and state dummies not reported; robust standard errors; p-value in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1