A STAFFING LEVEL SURVEY OF BIOMEDICAL ENGINEERING DEPARTMENTS IN CANADIAN HOSPITALS

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This study was conducted in the spring of 2003 as part of a graduating paper in the Master of Public Administration program at the University of Victoria. While the findings may be somewhat dated by recent trends — improvements in funding, and recognition of the role of BME in support of increasingly complex technology — the methodology is robust and the model itself can be updated by resurveying and, from the resurvey, adjusting the model's two coefficients.

The object of the study was to determine whether there exists a consensus among Canadian Biomedical Engineering Departments on a model relating technical support staff level to either of two easily-obtained parameters — acute bed count, and annual hospital operating budget. An attempt was made as well to account for further variations in staff level attributable to what I have termed "supplementary functions" — services performed by responding BME departments that are beyond the commonly understood core set of services.

This study presents the results of a survey conducted in early 2003 among Biomedical Engineering (BME) departments in twenty-three hospitals and health regions across Canada inquiring as to numbers of technical support staff, numbers of acute beds supported by the departments, annual operating budget of the institution, as well as some details that would reflect the level of support actually provided in-house by the respondents .

A search of the literature found a couple of earlier projects offering formulae for staffing levels. The present survey attempted to make a formula which is easier to use, less dependent on interpretation of terminology, and which provides some accounting for various "non-core services" performed by many of the responding departments. While the survey did ask respondents for data on management and clerical staffing in their departments, the focus of the project is the number of technical support staff, Biomedical Engineering Technologists (BMET's).

Methodology

The survey was conducted by initially selecting twenty respondents, using a membership list from the B.C. Clinical Engineering Committee and a directory of Canadian hospitals, the 'Guidebook to Canadian Healthcare Facilities, 2000-2001'. Three additional respondents were added later to examine differences between departments serving general hospitals and those serving pediatric hospitals.

A questionnaire was developed requesting information on three 'numerator' data items (numbers of technical staff, clerical staff, and engineers or managers); and four 'denominator' data items (acute bed count and hospital budget, number of operating rooms, annual number of addmissions) which might serve as workload surrogates. Additional information was obtained from the 'Guidebook' and from hospital websites.

The questionnaires were first sent out by email. Approximately one third of the participants responded without prompting. After an interval of two weeks the balance were contacted by telephone and the data was collected verbally.

In return for their participation the respondents were offered a full copy of the database, with all identification intact, on condition that the information not be disseminated outside the group without removing identifiers.

At the suggestion of several of the respondents who felt that the data didn't reflect certain extraordinary services they provided to their institutions, a second-round questionnaire was sent out, inquiring further into levels of activity in twelve "supplementary functions".

Reported BMET levels were analyzed in terms of acute bed counts, supplementary function scores and regional or hospital operating budget. The budget variable was abandoned, however,

because it correlated very closely with the acute bed count and therefore provided little extra information. Of the two, the budget figure correlation with reported staff levels was not as good as the more intuitive bed count based model. Using regression methods to build a multi-variable model (i.e. including both bed count and budget) also resulted in rejecting the budget variable as a contributing factor.

Results and Recommendations

The first benchmark derived from the analysis was a simple mean of the staff level, expressed as "Acute Beds per BMET". This was the approach taken by the earlier studies. The analysis found a mean of about 53 beds/BMET or

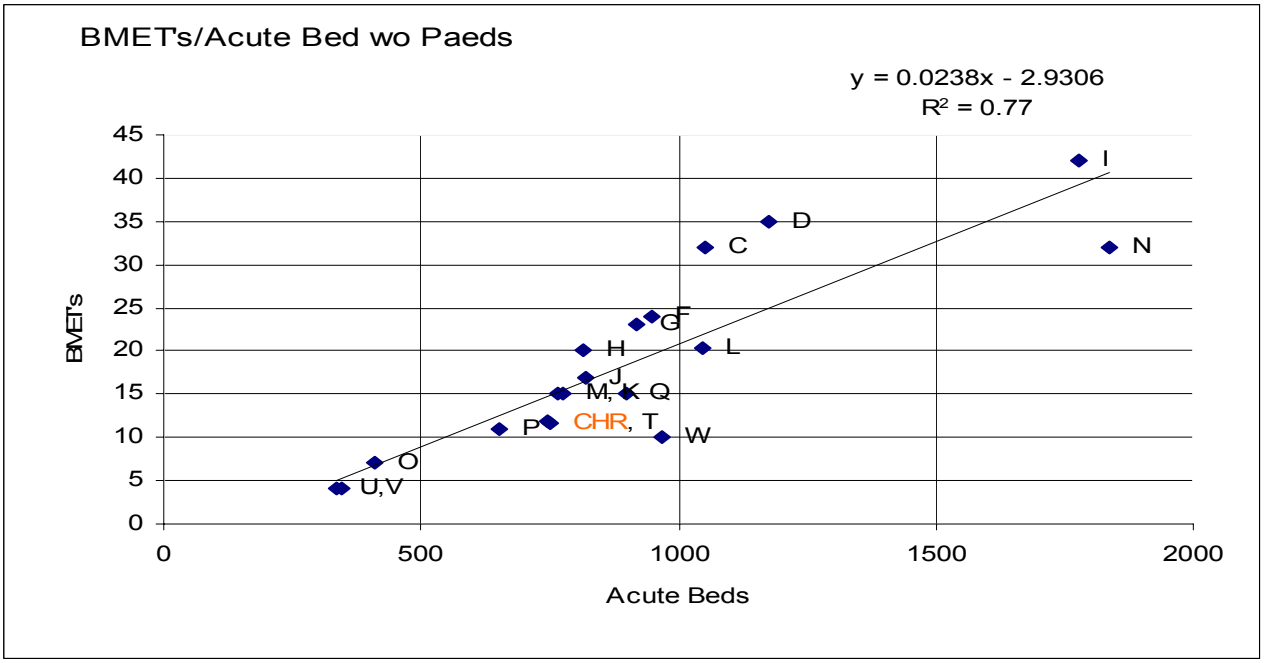
BMET's = .019 * (Beds)

(This formula is the equivalent to regression of BMET's as a function of number of acute beds, with the graph passing through the origin).

The model was refined by applying simple single-variable regression analysis, with BMET's graphed as a function of acute bed count, but with an offset (the graph not necessarily passing through the origin), producing the formula

BMET's = .024 * (Beds) – 3,

The decision was made to exclude the two purely pediatric hospitals from the model at this point because they both fell so far above the graph that it was apparent that the model would need extra refinement (i.e. additional variables) to account for their special support requirements.



Simple Regression: BMET's / Acute Bed, wo Peds

Although it is common to expect a benchmark of this sort to be expressed simply as a mean value, (e.g. 53 Beds/BMET) the graph in the above figure enriches the model by including the offset. Also, it shows a quite encouraging degree of correlation, R2 close to 0.77 when the pediatric respondents were excluded.

In this graph a regression line is fitted which, unlike the simple Beds/BMET calculation, doesn't necessarily go through the origin. The non-zero offset of this line may be interpreted as a minimum institution size (~ 150) below which, according to this model, an in-house BME staff isn't justified. This graph sould be

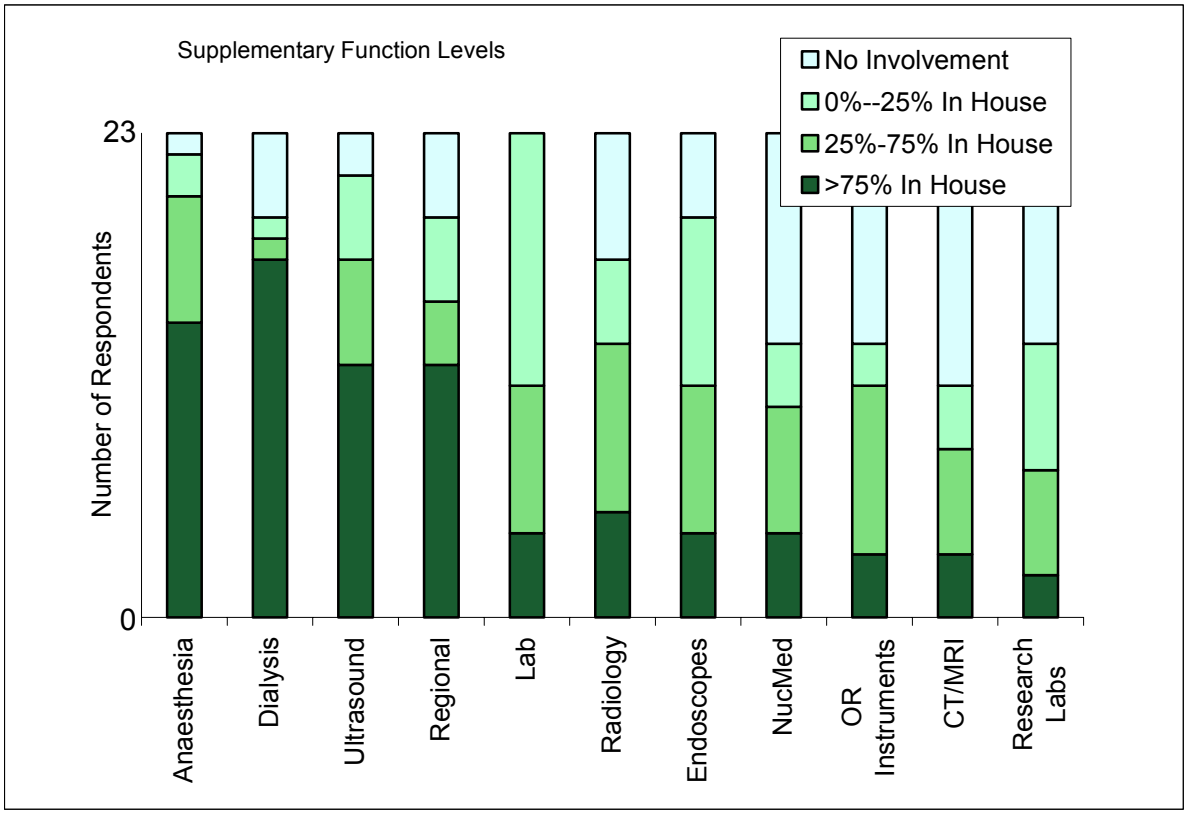
interpretted as follows: points below the line represent "lean" operations: the vertical offset of a point from the line represents the number of staff that would be needed in order to meet the benchmark model, given the institution's number of acute beds.

The second phase questionnaire listed twelve supplementary functions; the initial three I had included: Medical Imaging support (expanded into support of Radiology, Nuclear Medicine, Ultrasound, CT/MRI), Medical Lab, and Regional Service. Based on recommendation of Part I respondents, I added to the list: support of dialysis; endoscopy; OR instruments; anaesthesia; and research labs; and BME's involvement as medical equipment *operators* (as opposed to *supporters*). Responses to the supplementary function questions in the first questionnaire were simply yes or no. In the second, I attempted to increase the differentiation among the responses by allowing four possible replies and weighting the scores accordingly:

- No involvement at all (weighted as 0),
- 0% to 25% of demand for service met by in-house staff (weighted as 1),
- 25% to 75% (given a weight of 2), and
- 75% to 100% (weighted as 3).

For the response to the question on "medical equipment operators" the response was expressed in approximate FTE's involved.

The second questionnaire also provides, as a by-product, a who-does-what listing of supplementary functions performed by the responding departments.



During the Part II interviews many respondents had expressed curiosity about which of the supplementary activities were most commonly provided by other departments. This information is shown in the figure below. It shows, for instance that the function that is most commonly provided entirely in-house is Dialysis support. All respondents report providing at least *some* support of their Medical Lab, yet only a small number provide *full* support in this area. The function which at the time of the survey was untouched by the largest number of respondents is CT/MRI, which is almost always covered by some level of service contract.

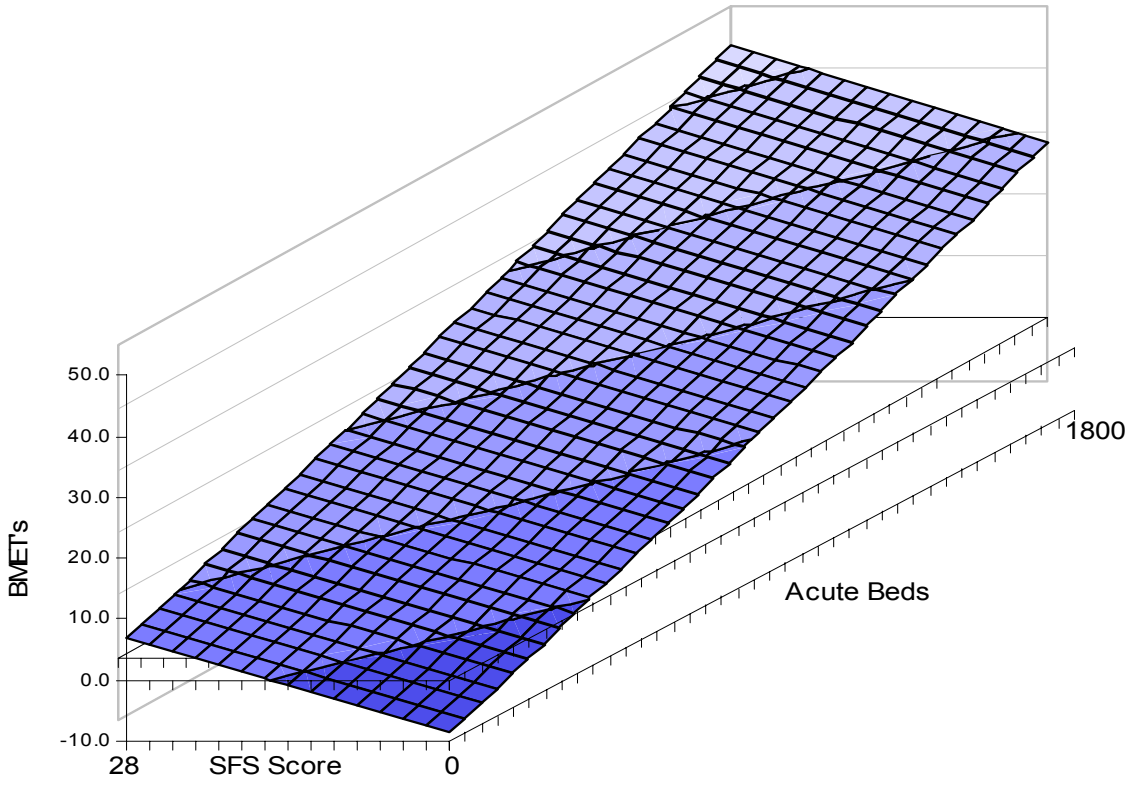
So further refinement was provided by multiple regression, expressing BMET's as a function of both bed count and supplementary function score (SFS), producing a formula

BMET's = .02 * (Beds) + 0.5 * (SFS) – 9.5

This may be interpreted as meaning

1 BMET for every ~ 50 beds + 1 for every ~ 2 SFS points with an initial offset of ~ -9.5

The offset means no staff if an institution doesn't have either 450 beds or its BME department performs less than 19 SFS points, or an equivalent combination. This represents a refinement of the 150 bed minimum produced by the simple regression model above.



Regression plane for BMET's (Acute Beds, SFS Score)

The two-variable graph illustrates this point; institutions falling in the dark blue region would not warrant in-house BME support.

Recommendations to Canadian BME community

Specifically addressing the findings of the survey;

a) for "struggling" stand-alone departments — look at benefits of consolidating with other BME departments — note that although some of the regional departments are required to travel large distances to provide their service, they nevertheless still fall close to the main regression plane; the burden of geography doesn't appear to make them stand out as a group.

b) for departments that appear to be over staffed — examine possible reasons for the appearance before accepting that you actually do have more staff than is justified; what other supplementary functions are being performed; are they ones that should be included in the model?

c) The study demonstrates the value of modest projects targeting narrowly defined questions; email communications make an undertaking of this sort much lighter and quicker than they were ten years ago. It could even be better: an investigation of other more sophisticated internet tools — both for conducting studies and for communicating the results — would be worthwhile.

d) Collective efforts should be undertaken to refine data definitions and communicate them to members of the community.

Further Research

Several projects could be readily spawned from this study, using the framework it provides.

An easily obtained benchmark based on dollars remains an attractive goal because healthcare accounts are reported reasonably consistently across Canada, and because dollars are "the currency" – readily converted, compared, and traded with other functions. A dollar-based model would be useful within Canada, but would be difficult to use in international comparisons because of the need to translate differences in salaries and other costs.

Quantifying *weights* for the supplementary functions. In the present model all supplementary functions are weighted equally. For instance, a follow-up survey asking the 13 respondents who indicated that they provide some service to Nuclear Medicine to quantify this effort in FTE's could provide a *weight* for scoring this function. The SFS formula would then be

$$\Sigma[(\text{level of involvement} \mid 0,1,2,3)_i * \text{weight}_i]$$

instead of

$$\Sigma\,[(\text{level of involvement} \mid 0,1,2,3)_i\,]$$

So if respondents agreed that the outlay for providing 100% support for their institutions' Nuclear Medicine departments is only half that for Ultrasound, this would be reflected in $weight_{US}$ and $weight_{NM}$.

One caution about pursuing more detail: there very quickly develops a tradeoff between precision and accuracy. Participants' inability to provide accurate figures, or their lack of interest in putting effort into the estimate negates the potential usefulness of getting a more precise model.

In this study I avoided the extra work providing a precise definition of *BME core technical service activities*, because there appears to be an unspoken understanding among respondents of what these entail. A survey clarifying the scope of "core activity" would be worthwhile.

Define more supplementary functions, with particular attention to those which might be unique to pediatric hospitals; this would go some way towards bringing them closer to the model. The data suggests that pediatric hospitals have a some supplementary functions which were not represented on this list, e.g. support of critical care incubators.