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Congenital heart disease and the cost of mortality

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MANUSCRIPT

Advances in medical care and technology over the past several decades have brought an unprecedented ability to expand the quality and length of patients' lives. Once debilitating and lethal diseases are now frequently treatable and at times curable. Evidence of this progress can be found uniquely in the field of paediatric cardiology. Only decades ago, complex congenital heart malformations such as hypoplastic left heart syndrome were uniformly lethal diagnoses with no option for surgical intervention or medical management.[1 2]

Newer and more sophisticated treatment options come with expanding use and dependence on increasingly costly medical and surgical interventions.[3] Use of these interventions has placed an increasing strain on medical systems often already under significant pressure. The adoption of evidence-based medicine has led to a significant effort to understand how our interventions drive patient outcomes such as survival, quality and cost burden. While some interventions may lead to a combination of reduced cost and improved patient quality of life, others are associated with significantly increased cost and may not significantly improve quality or duration of life.[1 3 4] The availability of more advanced interventions has shifted our thought process from 'can we do something?' to 'can *AND* should we do something?'. The latter question is difficult and not always palatable, particularly to physicians whose primary goal is to improve the quality and duration of patients' lives.

In the context of the medical system as a whole, patients with congenital heart disease (CHD) represent a small but particularly costly subset of the population. Prior studies have documented a disproportionately high cost of care for patients with CHD compared with general paediatric patients and this includes CHD admissions for non-surgical illness.[4–6] Previous data have identified risk factors associated with higher cost. Not surprisingly, complications and increased length of stay (LOS) have been associated with elevated cost during CHD admissions.[7–9] Other patient characteristics influence the cost of care in non-hospital based practices and, within the CHD population, certain subsets of cardiac lesions are associated with increased cost of care due to their complexity.[1 5 6 10]

Published recently in *Open Heart*, Danford and colleagues present data using a unique measure of cost of caring for patients with CHD: the mortality-related resource utilisation fraction (MRRUF).[11] The authors perform an in-depth examination of the cost paradigm of mortality-related hospitalisations. This study used the Paediatric Health Information System, allowing analysis over a broad range of institutions. The PHIS database was used to identify hospital admissions for specific CHD lesions of increasing complexity. The study then linked these admissions to hospital charge data and separated them based on outcome of mortality. Their primary finding was that a significant percentage of resource use was consumed for patients in whom the ultimate outcome was death. This effect worsened with increasing disease severity and increased in the single ventricular population with advancing age.

This study places a spotlight on the cost of hospital admissions ending with mortality but raises several questions of which the answers remain elusive and will be required when deciding how to use these data to effect positive change. As mortality itself does not incur cost, there should be consideration of the primary drivers of higher cost in patients with CHD experiencing mortality during their hospitalisation. These drivers include the expenses of cardiac surgery and acute or chronic complications. These primary drivers should be considered in devising solutions to lower costs at the same time we are continuing to improve outcomes such as mortality.

Cardiac surgery is costly and itself associated with significant mortality and

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morbidities. It would be reasonable to assume that hospital admissions in which surgical interventions occur have a greater rate of adverse events and mortality compared with those in which no surgery is performed; concurrently, the surgical intervention itself carries significant cost. Since cardiac surgery is simultaneously dangerous and costly, the MRRUF may be identifying the inherent link between cardiac surgery, cost and mortality. The study did not separately analyse or control for admissions with and without surgical intervention, therefore whether surgery plays a primary role in cost could not be determined. Age is an additional confounding factor, as admissions for younger patients will generally involve a higher percentage of associated surgical intervention compared with admissions for older patients; this difference may help account for the increased cost seen in the younger age ranges.

It is almost certain that a primary driver of both cost and mortality in this group of patients is the presence of complications, especially in the patients who have undergone cardiac surgery. Prior data have linked complications to outcome as well as to cost, and complications would be expected to form important mechanistic drivers of cost in hospitalisations associated with mortality.[7 9] This study did not specifically examine this relationship, but information on complications would not only help explain some of the costs associated with high MRRUF but would also allow a target to be created for potential improvement in overall costs and outcomes. Pasquali *et al*[8] recently demonstrated, using linkage between the PHIS database and the Society for Thoracic Surgeons Registry, that congenital cardiac centres with better overall surgical outcomes also had lower overall costs.

One important relationship identified in this study was the linear association between LOS and MRRUF. Not surprisingly, this finding is similar to findings of prior studies and underscores the need for strategies to control length of hospital admissions for all patients with CHD.[1 7 8] Additionally, as previously documented in cost focused analyses, higher complexity of the underlying cardiac lesion was associated with increased MRRUF. Thus institutions that take on high complexity patients will incur a disproportionate cost burden in our current medical system. Whether LOS and patient complexity by themselves are significant enough to account for all of the cost difference is difficult to discern; it was not evaluated in multivariate modelling and therefore ongoing future studies are needed. However, reduction of LOS does provide a target for reducing cost generally in this population.

These data can be interpreted by interested parties in several ways. While it would seem optimal to reduce resources spent on admissions destined to ultimately end poorly, great difficulty remains in our inability to pre-emptively identify hospitalisations that will end in mortality. Although we do have the ability to identify high-risk populations, to limit resources for all high-risk patient populations would seem to be the equivalent of surgical excision with a very blunt scalpel. It is also undesirable to perpetuate a system that discourages institutions from taking on complex high-risk cases. Rather, it would be more appealing to find a way to use these data to identify methods that would reduce cost in high-risk admissions. As noted above, focusing on the primary cost drivers of cardiac surgery, complications and length of hospital stay, will generally improve costs for this population. In addition, reduction of complications will likely have an effect on mortality as well. As noted by these authors, reducing mortality and hospital LOS may have the combined effect of significantly improving patient quality of care and reducing the burden to institutions and the greater medical system. Ultimately, the results of this study shed important light on a topic of great importance and set the stage for future research endeavours in this ever changing landscape of CHD.

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