provision of resources and referrals (15); and equity in transplant (including by race/ethnicity and socioeconomic status) should be an explicit and monitored goal within institutions.

Nevertheless, oppressive social structures will, invariably yet unfairly, make some less able to withstand the removal and replacement of their lungs than others. Achieving full equity in transplant, hence, also requires the realization of a more equitable society. ■

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Getting What You Pay For

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Health policy has a long and often unfortunate history of unintended consequences resulting from changes intended to improve health care quality and efficiency. This record extends to the intensive care unit (ICU), where researchers and policymakers have long sought to define who benefits from ICU admission and create policies that promote ICU utilization for only those who will benefit. Ethical and logistical barriers to randomization challenge prospective research defining who benefits from ICU care; as such, most research is retrospective and, thus, inherently plagued by confounding by indication.

In the United States, ICU admission is not specifically regulated. There are guidelines from professional organizations (1) and reimbursement policies delineating how physicians can bill Medicare for critical care services (2). But, the way hospitals use ICU beds varies greatly, as demonstrated by the substantial heterogeneity even among patients with the same diagnoses (3–5). ICU admission is also affected by organizational

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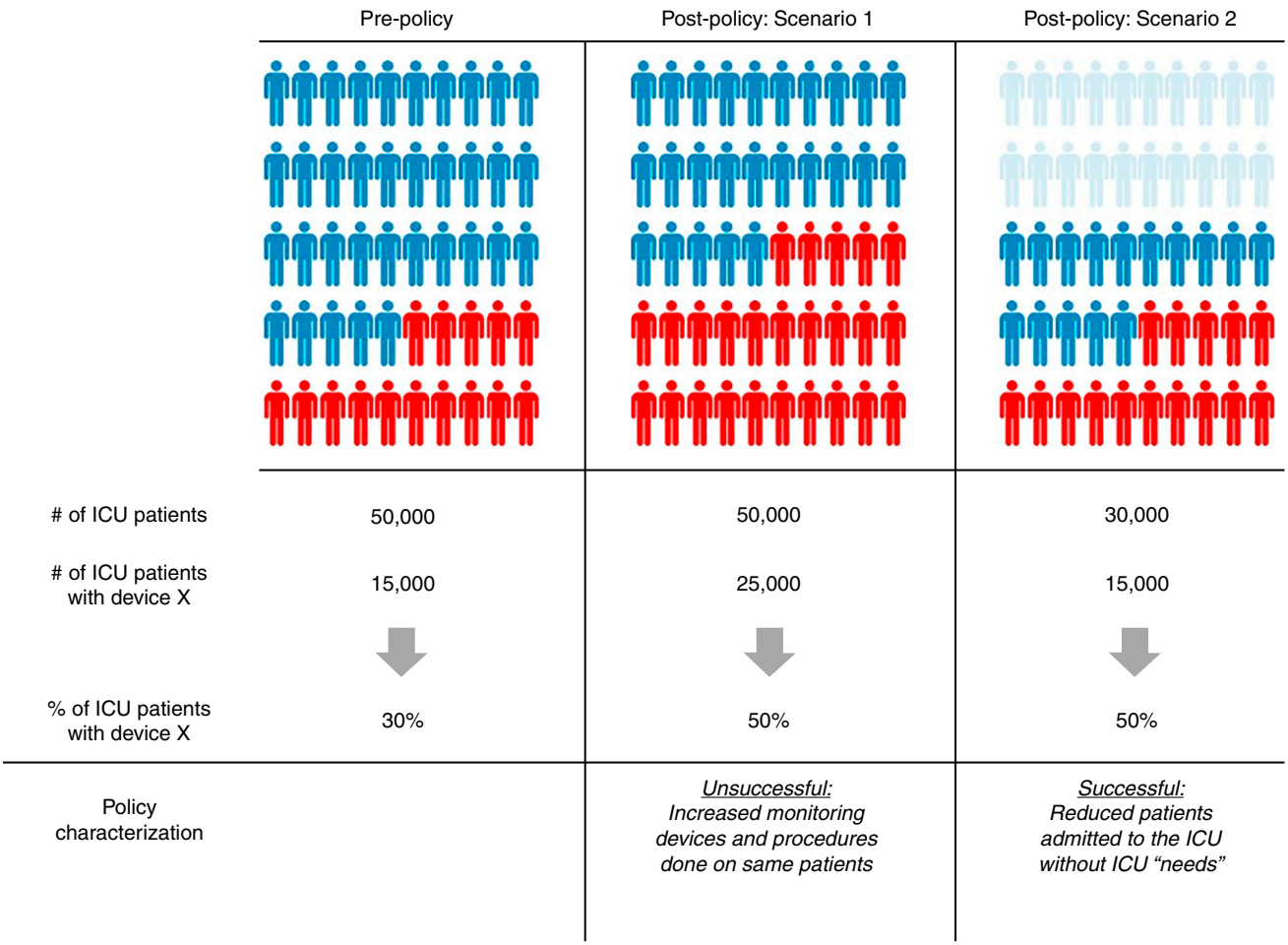

Figure 1. Example of successful and unsuccessful outcomes of an intensive care unit (ICU) admission policy intending to promote ICU admission for only patients who benefit from it. Each person represents 10,000 people, with red color indicating patients received device and were in the ICU; blue color indicating patients did not receive device and were in the ICU, and; the faded color indicating patients were not in ICU. In this example, an ICU admission policy specifying the use of monitoring devices and procedures could lead to two potential changes: (scenario 1) more ICU patients getting devices and procedures or (scenario 2) reducing the number of patients admitted to the ICU without an ICU need.

factors, as the use of an ICU bed may be impacted by hospital strain (3).

Japan aimed to standardize ICU admission criteria through national policy. As part of a universal health insurance system, to be reimbursed for ICU care, at least 70% to 90% of patients in each ICU must meet a score threshold. Points are assigned for the number of monitoring devices employed (e.g., invasive arterial, central venous, and pulmonary artery catheters, intracranial pressure monitors, and electrocardiograms) and procedures performed (e.g., mechanical ventilation, continuous renal replacement therapy, blood transfusions, and continuous medication infusions). The policy was issued in April 2014, with a six-month grace period after which each ICU was reimbursed only if the appropriate score threshold was achieved.

In this issue of *AnnalsATS*, Ohbe and colleagues (pp. 1013–1021) took advantage of this natural experiment, examining how Japan's new schema for reimbursement affected clinical and resource-related outcomes in a cohort of 1.6 million patients in 259 ICUs (6). Using interrupted time-series analyses, this study compared trends in outcomes before and after April 2014, when Japan's new policy took effect. The outcomes assessed were: use of the monitoring devices and procedures cited in the ICU criteria; clinical outcomes of in-hospital mortality, pneumonia, and catheter-related bloodstream infection during hospitalization; and resources including length of hospital and ICU stay, hospitalization costs, and ICU bed occupancy.

They found, unsurprisingly, that after policy implementation, there was a statistically significant increase in the use of nearly all the specified monitoring devices and procedures. The largest relative increases were in the use of invasive arterial pressure monitoring by 5.6% per year and central venous pressure monitoring by 1.2% per year. There were also statistically significant harms identified for all clinical and resource outcomes except in-hospital mortality, although magnitudes were small. The largest difference was 0.7% per year increases in both hospitalization costs and length of hospital stay after policy implementation. Hospitals that were successful in meeting ICU admission criteria in 2016–2017 had increases in the use of nearly all

monitoring devices and procedures coincident with longer lengths of stay, higher costs, and more complications.

Standing alone, it would be hard to know what to make of these results. What is demonstrated is an increase in the percent of ICU patients using monitoring devices and procedures; yet, percentages can be affected by changes in the numerator (more ICU patients getting devices/procedures) or in the denominator (fewer patients in the ICU overall) (Figure 1). Was it the case that the same patients were admitted to ICUs only now they had more things done (numerator change)? If so, the policy failed. Or, did the policy usher less sick patients (those without a need for invasive monitoring or procedures) away from the ICU (denominator change) as was its intent?

The authors explored this question in several ways. First, their primary analysis adjusted for patient-level characteristics and month of hospital admission in mixed-effects linear regression models, which should account for some changes in case-mix (denominator) over time. Second, they assessed changes in ICU bed occupancy and mechanical ventilation use for all hospitalized patients after policy implementation and found no statistically significant change, suggesting stability in the ICU population over time.

Finally, they included a clever sensitivity analysis in a population of near-ICU patients, those admitted to high-dependency units (also known as step-down units). These units were not included in the ICU admission policy and thus served almost as a counterfactual to the ICUs, or perhaps the location where less sick ICU patients were diverted. Among this near-ICU population, the authors found no significant increases in monitoring devices or procedures following policy implementation; in fact, decreases in rates of pulmonary artery pressure monitoring, continuous infusion pumps, and blood transfusions were observed. Interestingly, there were increases in lengths of stay and hospital costs in this near-ICU cohort, suggesting these outcomes in ICU patients may have resulted from something other than the ICU admissions policy itself.

Taken together, these findings suggest (although cannot prove) that the policy was unsuccessful. Rather than limiting ICU use to those most likely to benefit, it appears to have compelled the use of more invasive monitoring and procedures among an unchanged ICU population. While some of this may have been valuable, existing evidence suggests that such invasiveness alone is not beneficial (4, 5, 7–13).

In a thoughtful analysis of a national health system policy change, this study presents lessons for both Japan and other nations. It may seem obvious, particularly with the clarity of hindsight, that reimbursing based on the use of monitoring devices and procedures would lead to more monitoring devices and procedures. This is not unlike the fee-for-service payment policy experience of the United States. The choice to focus on devices and procedures is understandable as delineation of such activities is perhaps a cleaner way to define "needs an ICU" compared with other criteria. Medicare, for example, defines critical illness as that which acutely impairs one or more vital organ systems such that there is a high probability of imminent or life-threatening deterioration (2). Some conditions, such as shock requiring vasopressors or respiratory failure requiring mechanical ventilation, are undeniably critical illnesses by this definition, but many others are less clearly so.

ICU admission criteria are inconsistent due partly to a lack of knowledge about who benefits from ICU care and who doesn't. They are also necessarily impacted by the organizational contexts in which different ICUs are situated (i.e., whether there is a step-down unit in the hospital, staffing ratios on general wards). Defining universally applicable ICU admission criteria is, therefore, very difficult. Health care currently contains a mixture of payment systems that reimburse by diagnosis, specific services rendered, and outcomes. Each has its merits and pitfalls, yet one universal goal should be to incentivize high-value care. Without the ability to create universally applicable ICU admission criteria, however, how to financially motivate appropriate ICU use remains uncertain. What does seem to be clear is that paying for invasive monitoring and procedures is not a successful approach. ■

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Analyses of the Efficacy and Safety of Antifibrotic Therapies in Non-IPF Pulmonary Fibrosis, Progressing Despite Management

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In the this issue of *AnnalsATS*, readers have been treated to systematic reviews of the efficacy and safety of pirfenidone (1) (pp. 1030–1039) and nintedanib (2) (pp. 1040–1049) in patients with non-IPF pulmonary fibrosis (nIPF) with fibrotic lung diseases progressing despite management. This possible use of antifibrotic agents has been of worldwide interest. Historical management strategies have failed to meet the needs of patients once progression has occurred despite treatment, with forced vital capacity (FVC) decline strongly predicting earlier mortality in individual fibrotic interstitial lung diseases (ILDs) other than idiopathic pulmonary fibrosis (IPF) (3). Both reviews were undertaken to inform recommendations made in an impending ATS/ERS/JRS/ALAT (American Thoracic Society/European Respiratory Society/ Japanese Respiratory Society/Latin American Thoracic Association) clinical guideline. Literature searches disclosed a single nintedanib trial, the INBUILD trial (4), and two pirfenidone trials, the UILD and RELIEF trials (5, 6), all placebo-controlled and meeting the criteria for inclusion. In summary, it was concluded that nintedanib is efficacious in attenuating disease progression in patients with nIPF despite management, regardless of the radiographic pattern of fibrosis. Conclusions on the use of pirfenidone were more guarded, with statistically significant treatment benefits offset by the view that the certainty of beneficial effects is low on the basis of trial limitations. Side effects for both agents mirrored those observed in IPF antifibrotic trials.

A major strength of this approach, novel in our field, is the separation between the breadth of analyses used to inform a guideline group (analyses restricted to hard data) and the ultimate distillation of guideline statements, in which additional considerations are often important. Current guideline terminology used in previous IPF guidelines (especially the separation between the strength of evidence and the strength of a recommendation) allows the informed reader a partial insight into the key distinction between data abstraction and analysis and final guideline recommendations. But the forensic and detailed dissection of trial data exemplified in both manuscripts is a very welcome departure from past guideline presentations.

Furthermore, the presentation of data in both manuscripts is lucid. The basis of differential conclusions on the strength of the pirfenidone and nintedanib data is laid bare. The authors have not fallen into the trap of overemphasizing whether studies are "officially" positive based solely on primary endpoint analyses but have captured the full breadth of trial variables with a balanced distillation of all available data. It should be acknowledged that analysis of the pirfenidone data was a difficult task. In the UILD study, the primary endpoint (serial home spirometry) did not provide meaningful data, but serial FVC readings in lung function laboratories (the usual primary endpoint in IPF trials) were appropriately emphasized (5). Interpreting FVC trends in the RELIEF study was a courageous attempt given premature trial termination and the consequent problems of underpowering and a large number of missing variables (6).

This said, there are caveats that merit careful consideration. In analyses of both agents, the authors state comparisons in FVC decline between active and placebo arms, expressed as mean differences in mls/year and, in the case of pirfenidone, mean differences as a percentage of predicted normal values (1, 2). At first sight, this appears logical as the decline in FVC, expressed as mls/year, constitutes the primary endpoint in most ILD trials. However, attenuation of decline with active treatment cannot exceed the decline observed in the placebo arm. A mean difference of 100 mls in FVC decline, favoring pirfenidone in the UILD and RELIEF trials, representing a difference of 2.3% of predicted normal values, appears to be a weak treatment effect. However, approximately 50% of the decline was prevented compared with that observed in the placebo arms of these trials, an effect very similar to pirfenidone effects observed in IPF trials. The apparent significance of mean

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