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**ABSTRACT** Patients and medical professionals outside of the sleep community sometimes question the importance of treating obstructive sleep apnea (OSA) due to the perceived obtrusiveness of treatment options, and/or to ignorance about how OSA causes or exacerbates other disease. Many people are “visual learners” and thus absorb information more readily when presented as images instead of in text or speech. Therefore, we developed visual tools to help explain OSA pathophysiology and co-morbidity to patients and caregivers. We developed a set of diagrams (flow charts) that illustrate demonstrated or suspected relationships between OSA and other disease. To do this, we compiled the salient, peer-reviewed literature concerning OSA pathophysiology and specific co-morbidities. Actual and putative cause-effect relationships were identified and presented as specifically as possible. In addition, where the collective literature suggested existence of a “vicious cycle”, we portrayed this visually. When flow charts are viewed on a computer, the peer-reviewed article citations concerning specific relationships appear when you select (click on) that relationship. Flow charts were developed to present detailed pathophysiologic relationships between OSA and: obesity, hypertension, congestive heart failure, cerebrovascular disease, diabetes, gastroesophageal reflux, sexual dysfunction, and depression/anxiety. For example, one diagram depicts details of the vicious cycle between OSA and obesity (brief overview: obesity → OSA → somnolence → inactivity → dysmetabolism → obesity → ...). Our experience with these diagrams indicates they are substantially more effective than lecturing or written handouts to help patients understand how untreated OSA may contribute to other medical problems they confront. CME for caregivers has been well-received. Graphic illustration of OSA-related pathophysiology improves patient education. This in turn should help motivate treatment by giving patients a good understanding of how treatment may benefit them. Caregivers may be more interested than patients in the literature references for specific relationships shown on flow chart diagrams. The diagrams are easily modified and updated based on the most recent literature. Also, they are fractal, in that the depth and detail of information they present is limited only by the available literature.

## INTRODUCTION

Many patients and some caregivers perceive current treatment options for obstructive sleep apnea (OSA) to be obtrusive or irritating. Indeed, many things can go wrong with both positive airway pressure (PAP) treatment and oral appliances if not properly introduced and managed. Surgery is less effective and carries risk. Such problems raise questions about the need to treat OSA, particularly in mild cases.

To compound this problem, patients, medical professionals outside the sleep community, and insurers are often unaware of how OSA causes or exacerbates other disease. Research continues to accumulate linking OSA to a wide variety of other ailments. As this literature accumulates, some relationships become more or less well-established than others, but it becomes increasingly clear that OSA is a disease of multiple vicious cycles. By definition, such diseases tend not to self-correct, and instead worsen over time if left untreated. This emphasizes the need to treat even mild cases.

Unfortunately, lecturing and written material don't always prove effective as educational tools, particularly for lay people. Many people are "visual learners" and thus absorb information more readily and efficiently when it is presented graphically. Therefore, we developed a set of flowcharts to illustrate OSA pathophysiology and co-morbidity to patients and caregivers.

## METHODS

We analyzed literature concerning OSA pathophysiology and co-morbidities from Medline/Pubmed. For well-established findings, we cited recent review articles and occasional early seminal works. Original or editorial/hypothetical publications underlie less established relationships. Based on our interpretation of the literature, we developed a set of diagrams (flow charts) that illustrate demonstrated or suspected relationships between OSA and other disease. Where the collective literature suggested existence of a "vicious cycle", we portrayed this visually. We imported references into Endnote and then assigned them to diagram labels according to their content. The original graphics were prepared in PowerPoint and then converted to Smartdraw 5 to improve comprehension and facilitate Internet presentation.

## RESULTS

The central “mother diagram” provides a near-comprehensive overview of OSA-related pathophysiology. Key items on the mother diagram link to sub-diagrams which illustrate organ systems-level detail of relationships between OSA and obesity, diabetes, congestive heart failure, gastroesophageal reflux, lung disease, cognitive dysfunction, depression, etc. When viewed via Internet, references concerning specific diseases or pathophysiology appear when you select (click on) that item. The flowcharts emphasize the medical importance of the three pillars of physical health: sleep, activity, and diet.

## LIMITATIONS / OPPORTUNITIES

- This project is a work-in-progress. Both known and unknown omissions exist (e. g. renal disease, glaucoma, gout). Obviously, future research will modify and/or add to the presented relationships.
- Similarly, references provided are not intended to be comprehensive. We apologize for any key oversights and ask to know about them.
- We cited many of the references only on the basis of their abstract.
- The system lacks truly quantitative information.
- Linkage of references to *arrows between textboxes* would more specifically present data supporting causes-effects, but this was technically difficult. This is a future opportunity.
- We have not yet incorporated “vertical” integration of molecular, cellular, and tissue-level mechanisms of OSA pathophysiology.

## CONCLUSIONS

- Our experience suggests these diagrams are substantially more effective than lecturing or written handouts to help patients understand how OSA may contribute to other medical problems they confront, and thus how treatment may benefit them.
- This understanding translates into motivation to use treatment.
- In addition to previously identified vicious pathophysiologic cycles associated with OSA, the flowcharts illustrate some vicious cycles that to our knowledge have not previously been recognized.
- CME to caregivers has been well-received.
- We welcome all constructive criticism of this project. Have you published key works, or do you know of relevant and documented relationships, that are not cited or shown? If so, please inform us.
- Also, we invite assistance with vertical integration to the tissue-cell-molecular levels.

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- The original “mother diagram” was constructed for the National Sleep Foundation 2005 Pickwick Datablitz. We sincerely thank the NSF for all their contributions to sleep science and medicine.
- Finally, we acknowledge the many patients who inspired this work.