Microbaric® Oxygen Systems (MBOS) has obtained results from five preteens and teenagers diagnosed as having an autism spectrum disorder (ASD) treated with a new form of hyperoxic therapy called Microbaric® Oxygen Therapy (MBO₂). The first two of these case studies were commenced in November 2010.

For these cases, hyperoxic gas was supplied by licensed home respiratory care companies on the prescriptions of physicians. The breathing system was composed of FDA-cleared hardware used in accordance with its indications for use statements. This equipment and the therapy were easily incorporated into the families’ homes and schedules, and adapted to by the children with autism (Figures 1, 2, 3, and 4).

The only exclusion criteria for these cases were that the subjects not be taking any drug that reduced oxygen tolerance or any psychotropic agent that might mask improvements resulting from the therapy. Outcome data included periodic total and subscale ATEC scores (Autism Research Institute 2016) and accompanying subjective evaluations reported by the subjects' mothers. A summary of these results is given below. The complete subjective evaluations are given in accompanying documents. Those provided by the mothers of Subjects 1, 2, and 4 are particularly illuminating, providing great insight into the impact of this therapy on the subjects and their families.
SUBJECTS 1 AND 2

Subjects 1 and 2 were brothers in a family with four children, all boys, and their parents. Subject 2 was the oldest child and Subject 1 was the second oldest.

Subject 1: Subject 1 was formally diagnosed as having an autism spectrum disorder at three years of age. At seven, he was given a course of 20 one-hour hyperbaric oxygen treatments, administered twice daily over a two-week period in a typical clinical hyperbaric chamber (Figures 5 and 6). These treatments were considered beneficial by his parents – they “woke him up.” No objective assessment of Subject 1’s status was made in conjunction with the hyperbaric oxygen therapy, however.

Figure 5: Typical clinical monoplace hyperbaric chamber

Figure 6: Typical clinical multiplace hyperbaric chamber

Over the six-month period before MBO$_2$ was commenced in November 2010 when he was 12½ years old, Subject 1’s mother reported that he was in a declining state. He was depressed and defiant about everything. He would not go outside and had no tolerance of the sun. He had become pale, gray, and skinny. His appetite was non-existent. He kept the blinds in his room closed and answered, “no” to everything. Subject 1’s average baseline Total ATEC score at the outset of MBO$_2$ was approximately 101, just short of severely autistic (i.e., >104).

During MBO$_2$, Subject 1’s total ATEC score (Figure 7A) and sub-scale ATEC scores (Figures 7B-7E) declined dramatically, and he continued to improve following cessation of routine therapy after about 1½ years (i.e., 550 days). In practical terms, Subject 1’s mother reported that he become a totally different child and part of a totally different family dynamic than had been the case previously. He is now much more communicative and social; seeks out interaction with his siblings, which he did not do at all before; enjoys being outdoors, and is grasping more mature concepts such as money. He also shows signs that he will be more amenable and responsive to other forms of therapy (e.g., speech).
Figure 7: ATEC results for Subject 1 during baseline, treatment, and follow-up (over five years) periods. A – Total score; B – Communication subscale score; C – Sociability subscale score; D – Awareness subscale score; E – Health-Behavior subscale score.
Subject 2: Subject 2's mother reported that he first exhibited developmental abnormalities at age four. At that time, he was diagnosed as having attention deficit disorder. Further regression with the onset of irrational fears and demands occurred, however, and development of mental and social maturity slowed dramatically. He was diagnosed as having Asperger's syndrome when he was eight.

In the period leading up to the commencement of MBO, Subject 2 is reported to have had a very rough time through puberty and was “wired” constantly, staying awake easily for 36 hours at a time. Like his younger, autistic brother, he was depressed and defiant about everything. In addition, when he did not get his way, Subject 2 would go into a rage, lose control, and physically strike out at his siblings, parents, and even his grandmother. A psychiatrist was consulted and prescribed an antidepressant drug. After about three months when the drug was at its ultimate effectiveness, Subject 2's rages were even more severe. His parents abruptly terminated the antidepressant drug against the psychiatrist's advice and also rejected the latter's recommendation that they begin giving Subject 2 risperidone. After this, Subject 2's rages subsided to their former, unsatisfactory state. As he was still prone to uncontrolled rage and violence, his parents were seriously considering institutionalizing him.

Subject 2 was within several weeks of 14-years old when MBO was commenced. His average baseline Total ATEC score at that point was approximately 82. As with his younger brother, Subject 2's total ATEC score (Figures 8A) and subscale ATEC scores (Figures 8B-8E) declined significantly during the course of therapy.

In practical terms, Subject 2 is reported to have calmed dramatically, having no further attacks of rage after about six months of MBO. He also started to mature. He voluntarily threw out his juvenile toys and, for the first time, did not request a toy for his birthday geared to a child of a younger chronological age. For his fifteenth birthday, Subject 2 requested a full winter wet suit so he could swim in the pool and ocean later in the year.

Subjects 1 and 2: In summary, both Subjects 1 and 2 made dramatic progress in all ATEC subcategories as a result of MBO. This was not only to their benefit, but created a totally different and much happier family environment. It took an incredible burden off the boys' mother who was the primary caretaker. This change was brought about when the only interventions were MBO and longstanding dietary control and supplementation. With regard to the latter, their mother said, “vitamins and fish oil would have worked a decade ago if that were the magic bullet.”

Since ceasing regular MBO, their mother reports that Subjects 1 and 2 have continued to improve. The younger, more autistic brother (Subject 1) is shown in Figure 9 having spontaneously outfitted himself as a circus ringmaster. His mother's caption to this
**Figure 8:** ATEC results for Subject 2 during baseline, treatment, and follow-up (over five years) periods. A – Total score; B – Communication subscale score; C – Sociability subscale score; D – Awareness subscale score; E – Health-Behavior subscale score.
picture was, "autistic kids have no imaginative play." Among other things, Subject 1 now tunes into and participates in family discussions, routinely plays interactive games with his brothers, and has overcome a number of phobias. The older, initially violent brother (i.e., Subject 2) has gone from facing institutionalization to helping his father with projects around the house and taking responsibility for lawn care (Figure 10). Recently, the parents purchased a working farm so their autistic sons will have a safe place to live and work in the future while contributing to their own support. On this farm, the oldest brother, now 19 years old, plows the fields on a tractor (Figure 11) and performs other chores. His parents hope that he will be able to get an automobile driver's license in due course. Also, Subject 2 has become so reliable and caring for all of his siblings that his mother considers it a possibility that he will become the guardian for Subject 1 when she and her husband can no longer be responsible for him.

SUBJECT 3

Subject 3 was 17 months old when it was determined that he had an autism spectrum disorder. When 7 years old, he was given a course of so-called mild hyperbaric oxygen therapy (mHBO₂) which involved being sealed in a soft “chamber,” a pressure-resistant, reinforced-fabric bag (Figure 12), and breathing oxygen-enriched gas at increased pressure (i.e., 1.3 atmospheres absolute). The mHBO₂ chamber was located in the family home. These treatments were given for two hours a day, five days per week for three months. Then, two months were taken off, and the same cycle repeated. Over the course of about two-and-one-half years, some 900 hours of treatments were administered. Though no checklist or other objective measure was utilized to assess Subject 3’s progress during this course of therapy, his mother noted improved sleep, eating habits, and eye contact which did not regress following cessation of this therapy.
As time went on, however, his mother states that Subject 3 “seemed to hit a standstill on progress in all areas, socialization, academics, and language.” Thus, she sought a new therapy and was brought into contact with MBOS. Subject 3 was 10 years old when MBO$_2$ was initiated. At that point, his average baseline Total ATEC score was approximately 62. As shown in Figure 13A, Subject 3’s total ATEC score declined to a low of 37 during the course of MBO$_2$ and subjective reports on Subject 3’s health and behavior correlated with this.

After approximately five months, however, Subject 3’s improvement seemed to plateau and after about seven months (i.e., 215 days), MBO$_2$ was halted by his mother. About 5½ months following cessation of MBO$_2$, his mother noted that Subject 3 had not regressed subjectively from the improvements made in focus, concentration during academic tasks, reduction in aggressive behavior, and eye contact during the course of MBO$_2$. Similar reports were given at about 7½ months and 17½ months following cessation of MBO$_2$.

**SUBJECT 4**

Subject 4 was 2½ years old when he was diagnosed as autistic. Over the course of time, he had a number of interventions. These included applied behavior analysis (ABA) for thirty hours per week when he was four years old; a variation of ABA, verbal behavior, when he was 5 to 6; relationship development intervention (RDI); speech therapy from 4 to 10 years old; food supplements and vitamins. His mother felt that ABA and verbal behavior benefitted Subject 4’s academic efforts, but bored him; that the RDI was beneficial in Subject 4’s relating to others and involvement in “real life.” From a communication standpoint, prior to MBO$_2$, Subject 4 could sign about ten requests; had a very small vocabulary of basic words which he used in a slurred, quiet voice; shook his head, yes or no, in response to questions; looked at something he
Figure 13: ATEC results for Subject 3 during baseline, treatment, and follow-up periods. A – Total score; B – Communication subscale score; C – Sociability subscale score; D – Awareness subscale score; E – Health-Behavior subscale score.
wanted, raised his eyebrows to request it, and then looked at his mother for her response.

When he started MBO$_2$, Subject 4 was 12 years old, and his average Total ATEC score was approximately 113, a severely autistic and handicapped child, not only in terms of ATEC classification but also practical terms. The only other interventions Subject 4 was getting at that time were vitamins and food supplements. Over his course of MBO$_2$, however, he made dramatic strides as evidenced by his ATEC scores (Figure 14) and the subjective reports of his mother.

At the outset of treatment with MBO$_2$, Subject 4’s parents were uncertain if the initial significant drop in his total ATEC score and the changes in his behavior were the result of the treatment or simply imagined because of their own intense desire for him to improve. This doubt continued for a while until the changes in Subject 4 were so marked that his parents finally accepted them as real.

Among other firsts that ensued following the commencement of MBO$_2$, Subject 4 gave his mother a spontaneous kiss which he had never done before; in one week, cooperated completely in getting a hair cut, a medical examination, and a dental checkup with his teeth cleaned. In regards to the dental appointment, this was the first time Subject 4 had not needed to be sedated or restrained by several adults in order for the dentist to complete his work.

After the initiation of MBO$_2$, Subject 4 showed awareness of conversations between his parents and acted on what was being said without direction to do so. He also sought to play with other children whom he did not know. Needless to say, the life of Subject 4’s family changed dramatically over his course of MBO$_2$.

After about one year (i.e., 350 days), however, the family moved and an irregular living situation over the next year and then financial constraints prevented them from restarting MBO$_2$. Despite this, Subject 4’s ATEC scores and behavior did not deteriorate during the next two years and then, after he reached puberty, only in the Health-Behavior subscale results over the next 23 months (Figure 14E).

MBO$_2$ administration to Subject 4 was finally resumed in late June 2017. A point of significant note in this regard is that after essentially four years without treatment, Subject 4, who will turn 17 in July 2017, recognized the therapy equipment, helped his mother put it on him, and happily cooperated in the first of this new course of MBO$_2$ (Figure 15).
Figure 14: ATEC results for Subject 4 during baseline, treatment, and follow-up periods. A – Total score; B – Communication subscale score; C – Sociability subscale score; D – Awareness subscale score; E – Health-Behavior subscale score.
SUBJECT 5

Subject 5 was a high-functioning 18-year-old male with good verbal communication skills when MBO₂ was begun. He had significantly lower starting ATEC scores than any of the other subjects MBOS worked with. Despite there being relatively little room for improvement in comparison to the others cases, MBOS had special interest in Subject 5 because of his relatively advanced age in comparison to the other subjects at the outset of therapy.

Other than a number of ATEC results prior to and during therapy, there was little information forthcoming from the parents, and treatments were terminated rather quickly by the mother (i.e., after about 3½ months) because she felt no benefits were being achieved. Contrary to the mother’s subjective view, however, the Total ATEC scores she reported showed a steady decline following commencement of MBO₂ (Figure 16A). As indicated by the ATEC subscale scores (Figures 16B-E), this improvement came from the Sociability and Health-Behavior subscales (Figures 16C and 16E, respectively). MBOS’s conclusion from this case study, therefore, is that further trials of MBO₂ with older and higher-functioning individuals with autism are warranted.

SUMMARY OF KEY POINTS AND CONCLUSIONS FROM MBOS CASE STUDIES

The MBOS case studies, though anecdotal, add to the weight of evidence that hyperoxic therapy is a beneficial intervention for ASD. Unlike the administration of hyperoxic gases in hyperbaric oxygen therapy, however, MBO₂ has been effective without increases in pressure produced through the use of whole-body chambers. Thus, among
Figure 16: ATEC results for Subject 5 during baseline, treatment, and follow-up periods. A – Total score; B – Communication subscale score; C – Sociability subscale score; D – Awareness subscale score; E – Health-Behavior subscale score.
other advantages in comparison to hyperbaric oxygen therapies, MBO\textsubscript{2} is more convenient to administer and without the risks associated with compression to and decompression from increased pressure.

The five subjects in the MBOS case studies were 12, 14, 10, 12, and 18 years old (Subjects 1-5, respectively) when MBO\textsubscript{2} was commenced. In comparison to behavioral and other medical research on interventions for ASD, this is a notably old cohort. Despite this, improvements with MBO\textsubscript{2} were noted subjectively and objectively through reports from the parents and parent-rated ATEC scores, respectively.

Also, in stark contrast to psychotropic drug interventions for ASD, MBO\textsubscript{2} has produced long-lasting if not permanent results without any apparent side effects. Drugs such as risperidone, on the other hand, only have effect while the drug is at an adequate level in the body. Thus, a missed dose can result in transient return of the unwanted behaviors. In addition, psychotropic drugs have well-known side effects (Warren, Veenstra-Vander Weele, Stone, et al. 2011) including increase in appetite and weight gain, GI issues, heart arrhythmia, sudden cardiac death, and lethargy.

In the five case studies, MBO\textsubscript{2} produced dramatic improvements in three (i.e. Subjects 1, 2, and 4) resulting in significantly enhanced quality of life for both the subjects and their families, and more positive long-term outlooks for the afflicted children. These improvements were across the full spectrum of core symptoms of ASD and have persisted with further gradual improvements and no deterioration, other than in Subject 4’s behavior upon reaching puberty, for over 5 years, over 5 years, and almost 4 years, respectively. One of the subjects (i.e., Subject 2) progressed from facing institutionalization because of his extreme, uncontrollable violence to becoming a reliable and productive member of his family and capable of taking on responsibilities that will aid him in caring for not only himself, independently, but perhaps for others as well.

One of the two remaining cases (i.e., Subject 3) improved initially, but then reached a plateau after about 5 months and made no more advances. Follow-up for approximately 18 months after cessation of therapy indicated that the advances made as a result of MBO\textsubscript{2} were retained. We believe that the prior lengthy course of mild hyperbaric oxygen therapy this subject completed about one year before commencing MBO\textsubscript{2} was a relevant factor in this outcome. Based on MBOS’s current insights on the rationale for hyperoxic therapy for ASD, oxygen dose effects may have had a role in this outcome and adjustments to treatment protocols have been developed to address this.

The final case (i.e., Subject 5) involved only 4½ months of MBO\textsubscript{2}, but distinct though apparently subtle benefits appeared to be developing in those behaviors and conditions in which the subject was most affected.
Particularly in the three cases in which significant benefits occurred (i.e., Subjects 1, 2, and 4), Microbaric® Oxygen Therapy appears to have been responsible for attenuating or eliminating challenging behaviors in children with autism. In one case (i.e., Subject 2), these included extreme violence which was ultimately fully addressed by MBO₂ without the use of psychotropic drugs such as risperidone and their attendant side effects.

As final notes, though MBO₂ was administered in the subjects' homes in these trials, it is a therapy that, because of its nature, would also be very amenable to administration by non-specialists as part of school, other training, and group supported living programs. With respect to its relationship to other forms of therapy including behavioral, it seems that MBO₂ would be entirely supportive and facilitate more rapid and greater progress. Improved focus and interest in studies/learning activities were commonly reported as a result of MBO₂, and in the course of his therapy, Subject 4's mother reported that he seemed to have developed a very strong desire to be able to communicate through speech. In addition, in the case studies, it proved practical to conduct MBO₂ simultaneously with other forms of therapy or training (e.g., home schooling, working with a therapist).

In conclusion, based on limited and uncontrolled trials, MBO₂ appears to be an effective, safe, easy-to-administer, time-efficient, and cost-effective therapy with no known side effects. As such, it has the potential of providing pediatricians and others guiding the treatment of children and perhaps even the treatment of adults with autism with an intervention meeting the broad objectives set out by Myers and Johnson (2007):

“The primary goals of treatment are to maximize the child's ultimate functional independence and quality of life by minimizing the core autism spectrum disorder features, facilitating development and learning, promoting socialization, reducing maladaptive behaviors,...”

In view of these remarkable findings, the conduct of a controlled study of Microbaric® Oxygen Therapy to current scientific standards is imperative.

REFERENCES