Zacks Small-Cap Research

December 13, 2017
David Bautz, PhD
312-265-9471
dbautz@zacks.com

scr.zacks.com
10 S. Riverside Plaza, Chicago, IL 60606

Tonix Pharmaceuticals Holding Corp. (TNXP-NASDAQ)

TNXP: The Origin of the Smallpox Vaccine and the Implications for TNX-801…

Based on our probability adjusted DCF model that takes into account potential future revenues from TNX-102 SL PTSD, TNXP is valued at $13/share. This model is highly dependent upon continued clinical success of TNX-102 SL in PTSD and will be adjusted accordingly based upon future clinical results.

Current Price (12/13/17)	$3.80
Valuation	**$13.00**

OUTLOOK

Tonix Pharmaceuticals Holding Corp. (TNXP) is developing TNX-801, a live form of the horsepox virus, as a smallpox-preventing vaccine. A recent letter in the *New England Journal of Medicine* discussed the sequence analysis of a smallpox vaccine produced in 1902, which showed the highest degree of similarity to horsepox virus. This data lends credence to the idea that horsepox virus was the ancestor to the current vaccine strain, thus supporting Tonix's use of the newly synthesized horsepox virus as a smallpox-preventing vaccine.

The company recently released financial results for the third quarter of 2017. Tonix exited the third quarter of 2017 with approximately $29.3 million in cash and cash equivalents, which we believe is sufficient to fund operations through the end of 2018.

SUMMARY DATA

52-Week High	**$6.32**
52-Week Low	**$2.85**
One-Year Return (%)	**-16.30**
Beta	**2.92**
Average Daily Volume (sh)	**64,728**
Shares Outstanding (mil)	**8**
Market Capitalization ($mil)	**$30**
Short Interest Ratio (days)	**N/A**
Institutional Ownership (%)	**18**
Insider Ownership (%)	**4**
Annual Cash Dividend	**$0.00**
Dividend Yield (%)	**0.00**
5-Yr. Historical Growth Rates	
Sales (%)	**N/A**
Earnings Per Share (%)	**N/A**
Dividend (%)	**N/A**
P/E using TTM EPS	**N/A**
P/E using 2016 Estimate	**N/A**
P/E using 2017 Estimate	**N/A**

Risk Level	**High,**
Type of Stock	**Small-Value**
Industry	**Med-Drugs**

ZACKS ESTIMATES

Revenue
(In millions of $)

	Q1 (Mar)	Q2 (Jun)	Q3 (Sep)	Q4 (Dec)	Year (Dec)
2016	0 A	0 A	0 A	0 A	0 A
2017	0 A	0 A	0 A	0 E	0 E
2018					0 E
2019					0 E

Earnings per Share
(EPS is operating earnings before non recurring items)

	Q1 (Mar)	Q2 (Jun)	Q3 (Sep)	Q4 (Dec)	Year (Dec)
2016	-$7.41 A	-$4.97 A	-$2.90 A	-$2.08 A	-$15.41 A
2017	-$1.27 A	-$0.65 A	-$0.77 A	-$0.74 E	-$3.23 E
2018					-$2.55 E
2019					-$1.99 E

© Copyright 2017, Zacks Investment Research. All Rights Reserved.

WHAT'S NEW

Business Update

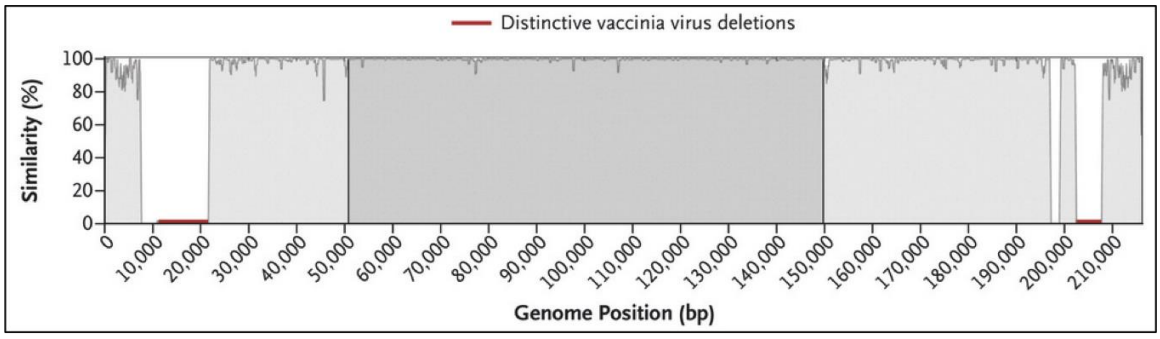
Tonix Pharmaceutical Holdings Corp. announced earlier this year that the company had successfully synthesized a smallpox-preventing vaccine. The vaccine candidate (TNX-801) is a live form of the horsepox virus and has already demonstrated protective activity in mice. While always thought to be based on a cowpox virus, new research has shown that the horsepox virus may be the ancestor of the smallpox vaccine, thus lending further support to Tonix's use of a horsepox virus for a new smallpox vaccine.

Smallpox Vaccine Origin

Edward Jenner was a British physician who is known as the father of modern vaccination. In 1796, he performed his famous experiment by taking fluid from "cow-pox" lesions on the hands of a milkmaid and inoculating an 8-year old boy in the arm. Six weeks later he challenged the boy with fluid from a smallpox lesion, however the boy did not develop smallpox. While Jenner did not know exactly how protection was conferred, we now know that infection with one member of the orthopoxvirus family (of which cowpox, horsepox, and smallpox are all members) results in cross-protection against other members of that viral family.

The term 'vaccination' was coined in 1800 (from the Latin word *vacca*, cow) and the material used for vaccinating (lymph from pustules) was interchangeably known as cowpox virus, vaccine, and vaccinia virus. While originally thought to have originated from the cowpox virus, in 1939 a British researcher showed that the smallpox vaccine and a strain of cowpox had different properties (Downie, 1939), which was further confirmed through genetic analysis (Dabrowski *et al*., 2013). For a full discussion on the historical development of the smallpox vaccine, interested readers should consult this review (Damaso, 2017).

While it is generally agreed upon that cowpox was not the origin of the smallpox vaccine, what virus(es) contributed to the current vaccine are still unknown. Additional insight into the mystery was recently revealed in a letter to the *New England Journal of Medicine* (Shrick *et al*., 2017). The group analyzed a smallpox vaccine manufactured in 1902 that was stored in glycerol. Following genetic analysis it was determined that the core genome of the virus had the highest degree of similarity (99.7%) to horsepox virus. The following figure shows the results of the genetic analysis, which also shows deletions in the 1902 vaccine strain not found in horsepox (or cowpox) virus (indicated by red bars). While not definitive, this data certainly strengthens the hypothesis that horsepox may be the ancestor of the smallpox vaccine strain.



Source: Shrick *et al*., 2017

TNX-801

Additional data showing horsepox as the virus that the original smallpox vaccine was based on is certainly encouraging news for Tonix and TNX-801's development. Professor David Evans, Ph.D. and research associate Ryan Noyce, Ph.D. constructed TNX-801 at the University of Alberta. Tonix wholly owns the synthesized horsepox virus stock and related sequences and the company has initiated manufacturing activities for additional preclinical testing. In order to gain approval, Tonix would need to show safety in a healthy adult population along with efficacy in two animal models, one of which would be non-human primates. Those studies would likely not initiate until 2018.

The company is hopeful that the newly synthesized vaccine will be safer to use than the currently available vaccine (ACAM2000®), which is not utilized as a prophylactic vaccine, except for certain military personnel (e.g., troops stationed on the Korean peninsula), due to safety concerns outweighing the potential benefit (Engler *et al*., 2015), however it is kept as a national stockpile in the event of a viral outbreak. The stockpile consists of approximately 300 million doses, and we estimate approximately 50 million doses must be replaced every year. Emergent Biosciences (EBS) recently completed the acquisition of the ACAM2000® franchise (which includes a contract for the national stockpile) from Sanofi for $125 million.

In addition to potentially selling TNX-801 to the U.S. government to be included in the national stockpile, approval of TNX-801 could include the issuance of a priority review voucher, which allows the holder of the voucher to receive an expedited six-month review from the FDA for a NDA or biologics license application (BLA) instead of the usual ten-month review. The 21st Century Cures Act created a priority review voucher for medical countermeasures, which are drugs or vaccines intended to treat biological, chemical, radiological, or nuclear agents that present a national security threat. A vaccine to protect against smallpox would almost certainly fall into that category. Priority review vouchers are also awarded for the development of treatments for certain tropical diseases and rare pediatric diseases.

Priority review vouchers are fully transferrable, and a number of companies that have been issued the vouchers in the past have sold them, including one that was sold to AbbVie (ABBV) in August 2015 for $350 million. The four most recent purchases are Gilead (GILD) for $125 million in Feb. 2017, GlaxoSmithKline (GSK) for $130 million in June 2017 (undisclosed seller), Teva Pharmaceutical Industries, Ltd. (TEVA) for $150 million in August 2017 (undisclosed seller), and BioMarin (BMRN) for $125 million in Nov. 2017 (buyer not disclosed). The following table shows how many priority review vouchers have been issued along with the current status of the voucher, if known.

Priority Review Vouchers

Voucher Award Date	Voucher Type	Voucher Awardee	Voucher Status
2009	Tropical Disease	Novartis	Used for BLA for canakinumab
2012	Tropical Disease	Janssen	Not used
2014	Rare Pediatric Disease	BioMarin	Sold to Sanofi for $67.5M on July 30, 2014
2014	Tropical Disease	Knight Therapeutics	Sold to Gilead for $125M on Nov. 19, 2014
2015	Rare Pediatric Disease	United Therapeutics	Sold to AbbVie for $350M on Aug. 19, 2015
2015	Rare Pediatric Disease	Asklepion Pharmaceuticals	Transferred to Retrophin and sold to Sanofi for $245M on May 27, 2015
2015	Rare Pediatric Disease	Wellstat Therapeutics	Transferred to AstraZeneca
2015	Rare Pediatric Disease	Alexion Pharmaceuticals	Not used
2015	Rare Pediatric Disease	Alexion Pharmaceuticals	Not used
2016	Tropical Disease	PaxVax Bermuda	Not used
2016	Rare Pediatric Disease	Sarepta Therapeutics	Sold to Gilead for $125M on Feb. 21, 2017
2016	Rare Pediatric Disease	Ionis Pharmaceuticals	Not used
2017	Rare Pediatric Disease	Marathon Pharmaceuticals	Not used
2017	Rare Pediatric Disease	BioMarin	Sold to undisclosed recipient for $125M on Nov. 27, 2017

*Note: Gilead purchased a priority review voucher during the second quarter of 2016, but who it was purchased from and for how much was not disclosed
GSK bought a PRV in June 2017 for $130 million
Teva bought a PRV in August 2017 for $150 million
Source: raps.org / Zacks SCR

HONOR Study Continues

Earlier this year, Tonix announced the first patient was enrolled in the Phase 3 HONOR study of TNX-102 SL 5.6 mg for the treatment of posttraumatic stress disorder (PTSD, NCT03062540). The HONOR trial is a 12-week, multicenter, randomized, double blind, placebo controlled, fixed dose study of 5.6 mg TNX-102 SL (2 x 2.8 mg tablets) taken at bedtime. Approximately 550 subjects who have served in the military and meet a diagnosis of PTSD according to the Clinician-Administered PTSD Scale (CAPS-5) for DSM-5 are eligible to enroll. The company recently increased the number of clinical sites from approximately 35 to approximately 40 to help facilitate patient enrollment. The primary endpoint of the trial is change in CAPS-5 at Week 12 (CAPS-5 will also be scored at Week 4 and Week 8).

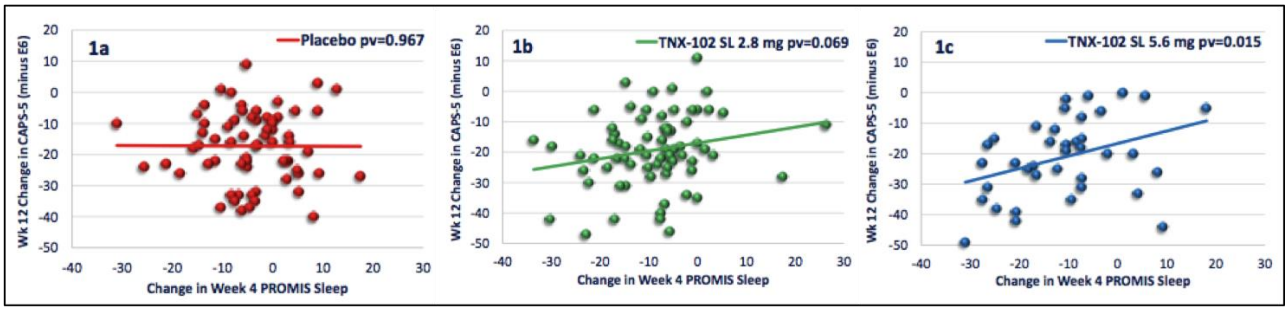
The CAPS is a structured interview designed to make a categorical PTSD diagnosis and provide a total PTSD symptom severity score, and is considered the “gold standard” in PTSD assessment and corresponds to the DSM-5 diagnosis for PTSD. The assessor combines information on frequency and intensity of an item into a single severity rating (0-4) for the 20 DSM-5 PTSD symptoms, thus patients are assigned a score with a maximum of 80 points possible. A higher score corresponds to more severe PTSD and patients are categorized as follows:

CAPS-5 Score	Category
0 – 10	asymptomatic/few symptoms
11 – 22	mild PTSD/subthreshold
23 – 34	moderate PTSD/threshold (moderate dx cutoff of 25 is a few points into the moderate range)
35 – 46	severe PTSD (stringent dx cutoff of 37 is a few points into the severe range)
47 +	extreme PTSD

There is one unblinded interim analysis scheduled when the study has results from approximately 50% of randomized patients (~275 patients). The interim analysis will be performed by an independent data monitoring committee. We anticipate this occurring in the third quarter of 2018. If the results of the interim analysis require continued enrollment, topline results from the 550 participants will likely be available in the fourth quarter of 2018.

Additional Data From Phase 2 AtEase Study Presented

On August 29, 2017, Tonix presented additional analyses of the Phase 2 AtEase study of TNX-102 SL for the treatment of PTSD. A retrospective analysis showed there to be a link between improvements in sleep quality at Week 4 and symptom improvement at Week 12 as measured by the CAPS-5. This data supports the mechanistic hypothesis that improving sleep quality and sleep-dependent memory processing was mechanism behind the therapeutic effect observed in the AtEase Study. As the following graphs show, there was no correlation between Week 4 sleep quality and the change in CAPS-5 at Week 12 for patients on placebo (1a), however there was a trend toward significance for those that took 2.8 mg TNX-102 SL (1b) while the trend was statistically significant for those administered 5.6 mg TNX-102 SL (1c).



Source: Sullivan *et al.*, 2017

Potential for Only One Phase 3 Trial for Approval

Following the receipt of the final minutes from a meeting held with the FDA earlier this year, Tonix announced that the FDA indicated it might consider a single-study New Drug Application (NDA) for TNX-102 SL based on statistically persuasive topline data from the HONOR study. Typically, the FDA requires two positive Phase 3 clinical trials. In addition, since there is no recognized abuse liability with TNX-102 SL, the FDA agreed that studies assessing abuse potential of TNX-102 SL would not be required as part of an NDA filing.

Positive CMC Meeting With FDA

On October 17, 2017, Tonix announced the receipt of the official minutes from a chemistry, manufacturing and controls (CMC) guidance meeting with the U.S. Food and Drug Administration (FDA). The meeting was held to discuss the data required to support the TNX-102 SL (Tonmya®) New Drug Application (NDA). TNX-102 SL is currently in a Phase 3 clinical trial for the treatment of posttraumatic stress disorder (PTSD).

The company announced that the FDA generally accepted the proposed CMC data package and commercial manufacturing plans for the production of TNX-102 SL. This shows that the company is ready to manufacture TNX-102 SL at production scale, should the drug be approved for the treatment of PTSD.

European Patent Granted for Treating PTSD

On September 14, 2017, Tonix announced the issuance of European Patent No. 2501234, which protects the use of TNX-102 SL active ingredient cyclobenzaprine for the treatment of PTSD. This patent, along with the U.S. composition of matter patent (US Patent No. 9,636,408), provides broad intellectual property protection in those

major markets. The European patent expires in November 2030, although it may be extended based on the timing of the European marketing authorization.

New Program Announced in Alzheimer's Agitation

On December 12, 2017, Tonix announced the completion of a pre-IND meeting with the FDA for the development of TNX-102 SL in agitation in Alzheimer's disease, which is associated with significant negative consequences for those suffering from Alzheimer's disease as well as their caregivers. There are no currently approved treatments for agitation in Alzheimer's, which is believed to be associated with sleep disturbances. Since TNX-102 SL is believed to improve sleep quality, the company believes it is a good drug candidate to be tested in that indication. Agitation is estimated to affect approximately 50% of the 5.3 million Americans currently suffering from Alzheimer's disease, and this number is expected to triple by 2050. We will provide a more in-depth look at agitation in Alzheimer's disease following the company's IND filing for the indication, which we anticipate occurring in the first quarter of 2018.

Financial Update

On November 7, 2017, Tonix announced financial results for the third quarter of 2017. As expected, the company did not report any revenues for the third quarter of 2017. Net loss for the third quarter of 2017 was $5.8 million, or $0.77 per share. R&D expenses were $3.9 million in the third quarter of 2017, compared to $5.5 million in the third quarter of 2016. The decrease was primarily due to the discontinuation of development work for the fibromyalgia program. G&A expenses were $1.9 million for the third quarter of 2017, compared to $2.1 million for the third quarter of 2016. The decrease was primarily due to a reduction in compensation-related expenses.

As of September 30, 2017, Tonix had approximately $29.3 million in cash and cash equivalents. On September 28, 2017, Tonix entered into a purchase agreement with Lincoln Park Capital Fund in which Lincoln Park has agreed to purchase up to $15 million of the company's common stock over a 30-month period. As of Nov. 3, 2017, the company has sold 248,340 shares of common stock to Lincoln Park for gross proceeds of approximatley $1.1 million.

As of November 3, 2017, Tonix had approximately 7.8 million shares outstanding. When factoring in the warrants with exercise prices of $6.30 and $6.88, the company has a fully diluted share count of approximately 8.4 million. Baker Brothers Advisors, a well-respected biotechnology hedge fund, took a position in Tonix earlier this year and currently owns 699,500 shares, or approximately 8.9% of all outstanding shares.

Conclusion

TNX-801 is an interesting program for Tonix, as it will not require a significant amount of capital in order to gain approval and there is the potential for a large payoff, both in the form of selling the drug as part of the national stockpile and the receipt of a Priority Review Voucher, which could potentially be sold for $100 million or more. Our current valuation for Tonix is based on a probability adjusted discounted cash flow model based on potential future revenues from TNX-102 SL in PTSD. Any revenue from TNX-801 could provide (potentially significant) upside to our current valuation of $13, and we will be following the development of TNX-801 very closely.

PROJECTED FINANCIALS

Tonix Pharmaceuticals Holding Corp.
Income Statement

Tonix Pharmaceuticals	2016 A	Q1 A	Q2 A	Q3 A	Q4 E	2017 E	2018 E	2019 E
TNX-102 SL (PTSD)	$0	$0	$0	$0	$0	$0	$0	$0
YOY Growth	-	-	-	-	-	-	-	-
Research & Collaborations	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
YOY Growth	-	-	-	-	-	-	-	-
Total Revenues	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
YOY Growth	-	-	-	-	-	-	-	-
CoGS	$0.0	$0	$0	$0	$0	$0.0	$0.0	$0.0
Product Gross Margin	-	-	-	-	-	-	-	-
R&D	$28.5	$3.0	$2.8	$3.9	$3.5	$13.2	$12.0	$13.0
SG&A	$10.4	$2.1	$2.0	$1.9	$2.1	$8.1	$8.5	$9.0
Operating Income	($39.0)	($5.1)	($4.8)	($5.8)	($5.6)	($21.3)	($20.5)	($22.0)
Operating Margin	-	-	-	-	-	-	-	-
Interest & Other Income	$0.1	$0.0	$0.0	$0.0	$0.0	$0.1	$0.1	$0.1
Pre-Tax Income	($38.8)	($5.1)	($4.8)	($5.8)	($5.6)	($21.2)	($20.4)	($21.9)
Taxes & Other	$0	$0	$0	$0	$0	$0	$0	$0
Tax Rate	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*
Net Income	($38.8)	($5.1)	($4.8)	($5.8)	($5.6)	($21.2)	($20.4)	($21.9)
Net Margin	-	-	-	-	-	-	-	-
Reported EPS	**($15.41)**	**($1.27)**	**($0.65)**	**($0.77)**	**($0.74)**	**($3.23)**	**($2.55)**	**($1.99)**
YOY Growth	*-46.2%*	-	-	-	-	*-79.0%*	*-21.0%*	*-21.9%*
Weighted Shares Outstanding	2.5	4.0	7.3	7.5	7.5	6.6	8.0	11.0

Source: Zacks Investment Research, Inc. *David Bautz, PhD*

© Copyright 2017, Zacks Investment Research. All Rights Reserved.

HISTORICAL STOCK PRICE



© Copyright 2017, Zacks Investment Research. All Rights Reserved.

DISCLOSURES

The following disclosures relate to relationships between Zacks Small-Cap Research ("Zacks SCR"), a division of Zacks Investment Research ("ZIR"), and the issuers covered by the Zacks SCR Analysts in the Small-Cap Universe.

ANALYST DISCLOSURES

I, David Bautz, PhD, hereby certify that the view expressed in this research report accurately reflect my personal views about the subject securities and issuers. I also certify that no part of my compensation was, is, or will be, directly or indirectly, related to the recommendations or views expressed in this research report. I believe the information used for the creation of this report has been obtained from sources I considered to be reliable, but I can neither guarantee nor represent the completeness or accuracy of the information herewith. Such information and the opinions expressed are subject to change without notice.

INVESTMENT BANKING AND FEES FOR SERVICES

Zacks SCR does not provide investment banking services nor has it received compensation for investment banking services from the issuers of the securities covered in this report or article.
Zacks SCR has received compensation from the issuer directly or from an investor relations consulting firm engaged by the issuer for providing non-investment banking services to this issuer and expects to receive additional compensation for such non-investment banking services provided to this issuer. The non-investment banking services provided to the issuer includes the preparation of this report, investor relations services, investment software, financial database analysis, organization of non-deal road shows, and attendance fees for conferences sponsored or co-sponsored by Zacks SCR. The fees for these services vary on a per-client basis and are subject to the number and types of services contracted. Fees typically range between ten thousand and fifty thousand dollars per annum. Details of fees paid by this issuer are available upon request.

POLICY DISCLOSURES

This report provides an objective valuation of the issuer today and expected valuations of the issuer at various future dates based on applying standard investment valuation methodologies to the revenue and EPS forecasts made by the SCR Analyst of the issuer's business.
SCR Analysts are restricted from holding or trading securities in the issuers that they cover. ZIR and Zacks SCR do not make a market in any security followed by SCR nor do they act as dealers in these securities. Each Zacks SCR Analyst has full discretion over the valuation of the issuer included in this report based on his or her own due diligence. SCR Analysts are paid based on the number of companies they cover. SCR Analyst compensation is not, was not, nor will be, directly or indirectly, related to the specific valuations or views expressed in any report or article.

ADDITIONAL INFORMATION

Additional information is available upon request. Zacks SCR reports and articles are based on data obtained from sources that it believes to be reliable, but are not guaranteed to be accurate nor do they purport to be complete. Because of individual financial or investment objectives and/or financial circumstances, this report or article should not be construed as advice designed to meet the particular investment needs of any investor. Investing involves risk. Any opinions expressed by Zacks SCR Analysts are subject to change without notice. Reports or articles or tweets are not to be construed as an offer or solicitation of an offer to buy or sell the securities herein mentioned.