Zacks Small-Cap Research

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SANUWAVE Health (SNWV-OTC)

SNWV: MundiMed JV Should Be Positive, But Just How Much Is Unknown

With the updates to our model, we have SNWV generating approximately $11M (when including JV revenue – which on GAAP basis will be accounted for as a component in equity interest calculation) in revenue in 2019 - based on the SNN comp 2019 P/S multiple, this values SNWV at about $0.30/share.

Current Price (10/04/17)	$0.19
Valuation	**$0.30**

OUTLOOK

Last week SNWV announced that they formed a joint-venture with MundiMed, a Brazilian distributor of medical devices. Based on forecasted revenue and expenses over the next ten years, management believes this JV will return net income, discounted back to the present, of $25M or more. We view this deal as an almost certain positive for SNWV, particularly given that it appears there is no upfront risk – financially or opportunistically, to the company. At the least, upfront payments from MundiMed should provide some meaningful (although potentially not overly significant) operating capital. Beyond that, it is a much larger 'unknown' as to how much, if at all, this JV will contribute to SNWV. While we are not modeling anything anywhere close to a $25M NPV at this point, the addition of the JV to our model has resulted in our SNWV per-share price target moving from $0.25 - $0.30.

Q2 results were announced in mid-August. Revenue was a 'dud' for the second straight quarter but management is still guiding for a major reversal in 2H.

SUMMARY DATA

52-Week High	**$0.20**
52-Week Low	**$0.08**
One-Year Return (%)	**23.00**
Beta	**-1.87**
Average Daily Volume (sh)	**174,009**
Shares Outstanding (mil)	**139**
Market Capitalization ($mil)	**$26**
Short Interest Ratio (days)	**N/A**
Institutional Ownership (%)	**0**
Insider Ownership (%)	**23**
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 2017 Estimate	**N/A**
P/E using 2018 Estimate	**N/A**
Zacks Rank	**N/A**

Risk Level	**High,**
Type of Stock	**N/A**
Industry	**Med Products**

ZACKS ESTIMATES

Revenue
(in 000s of $)

	Q1 (Mar)	Q2 (Jun)	Q3 (Sep)	Q4 (Dec)	Year (Dec)
2016	269 A	203 A	256 A	648 A	1,376 A
2017	150 A	111 A	371 E	648 E	1,190 E
2018					4,325 E
2019					8,641 E

Earnings per Share

	Q1 (Mar)	Q2 (Jun)	Q3 (Sep)	Q4 (Dec)	Year (Dec)
2016	-$0.02 A	-$0.01 A	-$0.01 A	-$0.02 A	-$0.06 A
2017	-$0.00 A	-$0.01 A	-$0.01 E	-$0.01 E	-$0.03 E
2018					-$0.02 E
2019					-$0.02 E

Zacks Projected EPS Growth Rate - Next 5 Years % **N/A**

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SNWV / MundiMed (Brazil) Joint-Venture

In mid-August, during the company's Q2 earnings call, management alluded to a potential agreement with a Brazilian organization that currently generates in excess of $5M in annual revenue. Then last week SNWV announced that they formed a joint-venture with MundiMed, a Brazilian distributor of medical devices. Per MundiMed's website, they operate in the hospital distribution market, mainly in the countryside of the state of Sao Paulo. MundiMed is part of GrupoMED, which is forecasted to generate almost $90M in sales in 2017.

Key terms of the deal are as follows;

- MundiMed will provide SNWV with upfront cash payments and other fees (undisclosed amounts) to be paid over the next 18 months – this is while they wait for regulatory approval in Brazil. SNWV received an initial partnership fee on 9/30/17 and will receive monthly partnership fees over the next 18 months
- MundiMed is responsible for the cost related to the formation, organization and start-up of the joint venture as well as for costs associated with regulatory approval
- Will share profits as follows; 45% to SNWV, 45% to MundiMed and 5% each to LHS Latina Health Solutions Gestão Empresarial Ltda. and Universus Global Advisors LLC, who acted as advisors in the transaction
- SNWV will provide devices at cost to the JV. The JV will place the devices and generate revenue on a per-treatment basis

SNWV noted that they evaluated several potential partners over the past 18 months and hired Universus to help with finding the right fit. They chose MundiMed after a due diligence period which included visits from both parties to each others' facilities. MundiMed also spent time with SNWV in their live territories in Europe.

Key aspects of the Brazilian health market and DFU (per our research);

- ✓ Approximately 12M Brazilians have diabetes. Prevalence of diabetes in Brazil, at about 8% - 12% (depending on the source) of the adult population, is similar to that of the U.S. (~10%) as is the incidence of foot ulcers (~5% - 8% of diabetics in both countries get DFUs) but amputation rates are much higher. Some studies (http://bit.ly/2xXMHZx) indicate approximately ~48% of Brazilians with DFUs undergo amputation - this compares to a rate of about 12% in U.S. This high rate of amputations is a direct indication of ineffective primary care of DFUs
- ✓ Direct costs of amputations in Brazil are "a very heavy burden" and major amputations (i.e. those above the ankle) are "life-threatening, leading to a poorer quality of life" and "result(s) in retirement which significantly influences the indirect costs" (http://bit.ly/2xXMHZx). An estimated 30% - 50% of patients requiring an amputation will require another amputation, which compounds the related cost burden
- ✓ Recent growth of the middle class in Brazil has meant an increase in vices that come with wealth including higher consumption of junk food. Roughly half of Brazilians are overweight and 15% are obese – just slightly less on both measures versus the U.S. In 2010 Brazil's Health Minister said of the growing obesity issue; "We are in a situation of red alert … We are sitting on a ticking time bomb!"
- ✓ According to researchers at Sao Paulo University, "…it is expected that the greatest social and economic impact of Type 2 diabetes in this century will be felt in the developing nations of Africa, Asia and South America, where national diabetes programmes are non-existent or ineffective and diabetic foot care remains inappropriate" (Rezende, et al.)
- ✓ Despite a burgeoning middle-class, there remains a huge division in wealth in Brazil with the southern portion, which includes large, urban centers, representing most of the wealth and the northern, rural areas, suffering with widespread poverty
    - Most hospitals are located in or near urban centers, exacerbating the difficulty of access to healthcare for the poor
    - Relatively wealthy population has access to private health providers, poor typically only have access to the national healthcare system which is free but congested and often understaffed and may not always provide specialized or advanced therapies
    - Approximately 75% of Brazil's population uses the national public health care system
    - Chronic (i.e. primary) treatment of DFUs is expensive which means the poorer classes may have little access to effective options
    - Highlighting these issues is the fact that maggot therapy continues to be investigated as a viable option for treating DFUs in Brazil given it's relatively low cost (Pinheiro, et al.)

- ✓ Lack of access to healthcare and education of diabetes and its deleterious effects on overall health have been cited as significant factors related to ineffective diabetes care and high amputation rates in Brazil (Santos, et al.)
- ✓ According to industry research firm, Mordor Intelligence, lack of proper reimbursement policies is one of the major challenges faced by the wound care management device market in Brazil

Regulatory

MundiMed is responsible for obtaining regulatory/marketing approval for dermaPACE in Brazil and will hire outside consultants to aid in the process. That process first includes a technical evaluation by Brazil's National Institute of Metrology, Standardization and Industrial Quality (INMETRO) – which is required for electro-medical devices and which we expect to be fairly straightforward (although will take time to complete). Then an application will be filed with National Health Surveillance Agency (ANVISA) – analogous to the FDA in Brazil. Management noted that they can use existing clinical data (such as the primary/pivotal and supplementary U.S. RCT data) to support the application and that no additional clinical studies will need to be performed. SNWV expects the entire process (which is already underway) to take between 9 and 12 months to complete and believe that they will be able to launch dermaPACE in Brazil before the end of 2018.

While we do believe the chances of eventually obtaining regulatory clearance in Brazil are favorable, it is less clear how attainable management's timelines are for doing so. According to the Emergo Group, which specializes in navigating regulatory processes throughout the world (and which claims to have registered hundreds of devices in Brazil), INMETRO testing/evaluation can be expected to take 5 to 6 months (following conclusion of any required testing by the sponsor) and ANVISA approval can be expected to take 1 to 3 months for Class II devices and anywhere from 8 to 15 months or even as long as 4 years for Class III devices.

To state the obvious though, Emergo's estimates are not specific to dermaPACE, or DFU-related therapies or even necessarily only to electrical medical devices (they also work with diagnostic companies) – and, as such, their estimates and SNWV's actual experience could differ. But we think it helps provide some context.

Similar to FDA, ANVISA categorizes medical devices based on their risk profile (Class I – lowest risk, Class IV – highest risk). Based on feedback from SNWV's/MundiMed's regulatory consultants, the expectation is that dermaPACE will be classified as a Class II device – assuming that will be the case, then management's 9 to 12 month estimate is highly consistent with Emergo's general guidance. If, however, it is considered a Class III device, it could be substantially longer until approval.

Management's Financial Guidance

SNWV will receive periodic payments during the first 18 months. These, along with device sales, we think will run through revenue in the income statement. The bulk of expected income from the JV will be related to per-treatment revenue – which should be captured as proportional equity interest in the JV.

Based on forecasted revenue and expenses over the next ten years, management believes this JV will return net income, discounted back to the present, of $25M or more (i.e. SNWV's portion of this JV is worth at least $25M on a NPV basis). While management did not disclose specifics surrounding all of their calculations, they did provide some data points and noted that the forecast and assumptions driving the model included input from MundiMed, who presumably has more insight into Brazil's chronic wound segment and the country's healthcare system.

In terms of the target markets, the JV will focus on both DFU and VLU – which combined we estimate at approximately 2.0M – 2.5M people and roughly evenly split between the two indications. While the U.S. clinical studies included only DFU, VLU's are similar in many respects including their chronic and advanced nature and difficulty in treating.

Management's $25M NPV is based on the assumption that they capture approximately 5% of the target markets within the first five years following launch in Brazil. This includes approximately 1% penetration in year 1. While reimbursement is currently only in the form of a tracking code, the expectation is that a dedicated code (specifically for dermaPACE), supported by pharmacoeconomic studies (demonstrating the health and economic/financial benefits of covering dermaPACE procedures) is attainable within the first 6 – 12 months following launch (in the private health care segment, possibly longer in the public sector).

Per-treatment revenue should provide significantly wider margins as compared to the (traditional) device-sales revenue model. Operating expenses also may be lower than they might under a device-sales model given that it may afford a less significant sales/marketing budget.

Our Comments:
We view this deal as an almost certain positive for SNWV, particularly given that it appears there is no upfront risk – financially or opportunistically, to the company. At the least, upfront payments from MundiMed should provide some meaningful (although potentially not overly significant) operating capital. Beyond that, it is a much larger 'unknown' as to how much, if at all, this JV will contribute to SNWV. We are not modeling anything anywhere close to a $25M NPV at this point.

Based on our own research, we think the Brazilian market might be more attractive than most based on several factors including the combination of what appears to be an ineffective public healthcare system (of which ~80% of the population relies upon) and a disregard for addressing diabetes which has created an environment that will be forced to make substantive changes. In addition, the very high DFU-related amputation rates and related costs as well as growing middle-class wealth, which is predicted to result in higher rates of diabetes, will all likely compound the problem. The public health system in Brazil, like many national health care systems throughout the world (including those in highly developed areas such as the U.K.), consider cost as a major determinant in available treatment options. dermaPACE almost certainly offers a lower-cost option as compared to other advanced wound therapies such as skin substitutes and VAC – which are also more invasive. The lack of available and cost-effective advanced wound options has also likely contributed to the high amputation rates – amputations are also relatively costly, particularly because they often require longer hospital stays as compared to primary-healed wounds.

We are modeling much lower penetration and reimbursement rates, however, as compared to what management indicated that they believe is attainable in the first five years. We also model only the DFU, and not the VLU market, given dermaPACE clinical data mostly relates to the former. We also note that much of the diabetic population resides outside of the major cities and instead lives in much more rural areas which have less access to major hospitals and clinics. These rural populations also account for a higher proportion of related amputation rates. Evidence has also indicated that while the lack of advanced wound care options is problematic in Brazil, factors such as lackadaisical efforts towards implementation of effective diabetes programs and lack of access to healthcare may be even more problematic (i.e. amputation rates may not necessarily be improved with a better, cheaper wound-care solution). And while MundiMed's distribution reach, particularly given their association with GrupoMed, may extend far beyond Sao Paulo and other large urban areas in Brazil, we think initial adoption is most likely to be largely concentrated within the most-accessible (i.e. urban) areas. And finally, the reimbursement picture is cloudy and given that coverage is often the most important gatekeeper to utilization, until there is more definitive insight into the likelihood of 'sufficient' reimbursement, we think this also warrants a more conservative forecast to uptake, adoption and reimbursement rates.

This is not to suggest that 5% penetration within the first five years is necessarily an aggressive forecast, but with no history of anywhere near that level of utilization to-date, we are taking what we think is a pragmatic approach to modeling this JV. We also believe the implied very low level of operating costs that are factored into the $25M NPV are aggressive. Our model is subject to updating, however, particularly if more relevant information becomes available. Contribution from the JV has now been factored into our model (see our Valuation section).

Q2 Results, Operational Update: *Disappointing Revenue, But Still Guiding for a Big Pick-Up in 2H….*

In mid-August SANUWAVE reported Q2 financial results and provided a business update. Relative to the financials, revenue was disappointing, falling significantly on both a yoy and qoq basis and coming in at less than one-half of our estimate. In fact, this was the second consecutive quarter in which revenue was pretty much a dud. For additional context of just how bad recent sales have been, revenue in the first half of 2017 represents the worst showing of any consecutive six-month period since Q1/Q2 2010.

Nonetheless, based in part on what they indicated was a significant steepening of orders post-Q2, management was still shooting for revenue to set a new record for the full year-2017. Optimistic, particularly given that 2H sales will need to be more than 4x that generated in 1H? Perhaps, yet comments on the call including the indicated jump in order flow in July, anticipated revenue from the recent onboarding of additional distributors and countries, and what may be a resurgence in activity from the ever-important territory of S. Korea should provide at least some hope that it is a possibility. And with the MundiMed JV now consummated, it is also possible there could some related revenue from that channel – potentially in the form of initial device sales (for training purposes) as well as from the upfront (and subsequent) payment.

Relative to the operational update - while the De Novo application and what FDA's response will ultimately be remain the most significant topics, there have been recent international-operations related activities (in addition to

the MundiMed JV) that have also been of interest - most of which surround expansion of the geographic footprint. We talk about the U.S. and OUS strategies and operational updates in more detail below.

Financials
Q2 revenue was$111k, representing a yoy and sequential decline of 45% and 26%, respectively, and 55% below our $244k estimate. Revenue in 1H 2017 was just $261k, down 45% from the same period in 2016 and 71% from 2H 2016 (i.e. sequentially). While it is not completely clear why revenue seems to have fallen off of a cliff, management's comments on recent conference calls indicate that the recent softness may be related more to timing than fundamental weakness in demand.

However, there do seem to be some tangible issues that have been a headwind to growth. This includes relatively modest contribution from S. Korea - which had been a strong contributor in 2016 (particularly in Q4), but which appears to have been a disappointment during the current year. Management has pointed to political turmoil in that country (related to the recent arrest of their President) as having an adverse impact on sales of their products. SNWV, per comments on the Q1 call, had expected revenue from that country to pick back up, however, with the anticipation that reimbursement would come online and help stoke demand. But, clearly we saw to little-to-no improvement in the Q2 results. We think that there are reasons to be optimistic that S. Korea can again be an important territory for SNWV including the recent issuance of a temporary reimbursement tracking code (with the possibility that a permanent code is assigned in the future) as well as initiation of dermaPACE clinical studies in that country in an effort to further validate utility and effectiveness of the device.

Another apparent issue, which SNWV alluded to on the Q2 call, has been that while some distributors may have expertise in wound care or orthopedics, that relying on them so detail to both markets may not always work. Management mentioned that they were in-process of re-evaluating certain of their distributor relationships in Europe to better address these distinct call points.

Q2 OpEx was $1.4M, which was significantly higher than our ~$800k estimate as well as the $950k quarterly average in 2016. Much of the difference, however, relates to ~$500k in non-cash stock compensation.

Cash used in operating activities was $458k and $573k ($850k and $1.60M, ex-changes in working capital) in the three and six months ending June 30, 2017. Cash balance was $62k at Q2 quarter-end. SNWV continues to expect monthly cash burn to average $125k - $225k through the remainder of 2017. While the upfront and subsequent (over the first 18 months) fee payments from MundiMed should provide incremental capital, it will not be enough to fully fund operations. SNWV indicated that they have been evaluating similar agreements with potential partners in India, China and the Middle East which, if closed, could also possibly bring in additional funds to the company. Burt, we continue to expect the company to look to raise additional cash via the sale of equity or debt or potentially through one or more partnering arrangements.

International Strategy…
As a reminder, earlier this year management outlined several goals that they expected to accomplish by year-end including the onboarding of an additional 7 - 10 new distributors/territories. Including the MundiMed JV, they are now at number six and based on comments on the Q2 call, management is confident that they will further expand their international footprint by the end of 2017. While many of the recent additions are in the orthopedics space, MundiMed adds a high-potential wound care channel and other DFU opportunities could follow - which could be facilitated if and when dermaPACE is approved in the U.S. (as OUS uptake is likely to benefit from implied validation that comes from FDA approval). SNWV is also currently evaluating several wound care related distributors in parts of Europe.

Recent "wins" on this front included the signing of major distributors in Taiwan and Indonesia as well as engaging an organization in Columbia to source qualified distributors in that country. Romania is another country where they also recently added distribution. SNWV is also active in looking to expand to other parts of Asia (including China and India) as well as to the Middle East and S. Africa – all of which represent relatively large populations and could be particularly well-suited for a MundiMed-type arrangement (i.e. JV with large, local and experienced distributor). Management mentioned that they already have several distributor-related meetings lined up for MEDICA, held (in Germany) in mid-November – results of which we might here about on the Q3 call (typically held around the same time).

SNWV recently updated their strategy in selecting distribution partners with additional emphasis placed on expertise in wound care versus orthopedics given the differences and difficulties in detailing to two distinct end-markets. Management also noted that some of their distributors - notably Alat Medika (a prominent Indonesian med-tech company) - also have the capabilities to help facilitate clinical trial activities in their respective territories.

As we have noted in the past, given the dearth of non-invasive and relatively inexpensive DFU-treatment options, we think dermaPACE has a place in chronic wound care and believe a reasonable scenario exists where SNWV can reach a point of operating profitability from OUS business alone. Clearly, much of the ultimate success of the international strategy may rely on partnering with organizations with sufficient and appropriate expertise, contacts and channel depth (at both private and national healthcare levels) to execute their strategy. We have yet to see much substance (in the form of revenue) from this international expansion - although given the lag between fundamental operational progress and related revenue, the next few quarters should be a much better judge in that regard.

This international strategy involves targeting key opinion leaders to help drive adoption. Management noted that it typically takes about 3 – 9 months after a new distributor/territory comes online to be able to assess the potential of the launch and before any significant related revenue may be generated. As such, assuming SNWV continues to expand their distribution footprint through the remainder of the current year, much of the revenue benefit may not be realized until 2018. Nonetheless, management noted that new distributors are required to purchase at least two systems initially ($40k - $60k revenue) which means the initial fruits of the recent geographic expansion should be apparent by 2H of this year.

As noted, management mentioned on the Q2 call (mid-August) that they had record shipments in the month of July and that they continue to believe 2017 will be a record year in terms of revenue - assuming that turns out to be the case, that should provide at least more substantive validation of the merits of their international strategy. It might also provide an additional glimpse of what an ex-U.S. path (in the event of an adverse FDA decision – although we do not think that will be the case) towards profitability might look like.

In Parallel…

In parallel to broadening their geographic footprint SNWV will also look to expand the indicated uses for their device. While SNWV's tight cash constraints have meant that certain clinical validation studies have moved slower than previously anticipated, further progress is expected to made over the coming months. One or more of these studies could have results published by the end of 2017. These include:

- **Belgium DFU Home Care study**: SNWV has partnered with Ortho-Medico, their distribution partner for the Benelux region, in sponsoring a clinical trial evaluating dermaPACE in the treatment of diabetic foot ulcers in the home-care setting. The trial, which recently commenced enrollment, is being conducted by the Free University of Brussels and UZ Brussel (University Hospital) and is expected to include ~100 DFU patients randomized to either dermaPACE or standard-of-care. As all patients will be treated in-home (i.e. outside the clinic/hospital), results of the study are expected to help broaden the potential international customer base to users such as home-health professionals and organizations. As DFU patients often have significant mobility limitations and challenges, trips to the hospital for treatment can present substantial hardship. As such, we think home-health could be a particularly attractive segment for dermaPACE and one that results of this study, assuming positive, could help SNWV to exploit.
- **Australian Venous Leg Ulcer studies**: SNWV's Australian distributor, in collaboration with researchers in Melbourne, has participated in several case studies using dermaPACE in venous leg ulcers. Case study included seven patients - management noted on the Q2 2017 that this study has now completed.
- **S. Korea**: several devices placed at leading universities in S. Korea with the goal of facilitating clinical evidence of effectiveness of treating DFUs.
- **U.S. studies**: In addition to DFU, SNWV is investigating the use of their technology in the healing of post-operative scars and in improving vascularization – both of which lend themselves to dermaPACE's method of action – that is promotion of blood flow and related healing. While these studies are still in the early planning stages, management did offer some general information on the Q4 2016 call - including that the post-op scarring program may initially involve patients undergoing elective cosmetic surgery (such as tummy-tucks) with each patient representing both treatment and control arms (e.g. one incision scar would be treated with dermaPACE, while the other would receive standard-of-care). If deemed successful, larger studies could follow – including potentially overseas.

FDA Pathway Update…

While management noted that they will continue to follow their policy of disseminating any material news as it relates to their quest towards FDA clearance of dermaPACE via press releases, they do continue to provide brief updates on the status of their de novo filing with FDA on earnings calls. As a reminder SNWV filed their de novo application on July 23, 2016 requesting that dermaPACE be classified as a Class II device.

In early 2017 SNWV received from FDA additional questions regarding clarifications related to the filing, clinical trial data and "technical performance and labeling." Management noted on the Q2 call that they submitted their responses to these questions on July 17th and responded to subsequent questions from the agency during the week-ending August 23rd. Since then SNWV has received regular, yet less formal, inquiries from FDA – management indicated on the MundiMed call (Sept 28th) that they have sufficiently responded to these requests.

Based on MCRA's experience, they believe a final response (i.e. yes or no) from FDA will come by current year-end. Specifically, management believes the November/December 2017 timeframe is a reasonable expectation. See our Appendix for refresher on dermaPACE U.S. pivotal studies as well as the de novo filing.

Model update:

We are maintaining our assumption that dermaPACE receives FDA clearance in late 2017. We also maintain our projected launch of dermaPACE in the U.S. in 1H 2018. And while we think the de novo pathway makes sense based on the reasons we cite, given the ambiguity in terms of FDA's decision-making process along with other unknowns including anything that may be unique to the switch from PMA to de novo, we are maintaining a high (i.e. 70% sales haircut) revenue discount.

We believe that our assumed, yet risk-adjusted, eventual FDA clearance/approval is a reasonable assumption given FDA's continued engagement with SNWV, strong safety profile of dermaPACE, significant efficacy on 100% wound closure in the combined data as well as efficacy in sub-groups (even at 12 weeks), on secondary measures and less invasive nature of dermaPACE compared to other DFU therapies. This is further reinforced by SNWV sufficiently addressing and responding to FDA's questions.

Our 70% haircut represents risk that dermaPACE fails to gain regulatory approval as well as certain operational risks including failure to raise additional capital, slow adoption of dermaPACE upon launch and insufficient sales/marketing capabilities (whether that be in-house or via 3rd party distribution), among others. **Additional positive and tangible headway towards approval as well as mitigation of other operational risks would likely warrant a reduction in this risk discount (and would likely benefit our price target).** We have dermPACE launching in the U.S. in 1H 2018. We model 2019 (the first full year that dermaPACE is in U.S. market) U.S. revenue of $16.5M – which equates to $5M with the risk discount.

We had not previously and still do not incorporate any potential contribution from non-medical applications or expansion of the U.S. label in additional indications including (for example) post-op scarring. This is also subject to updating and is contingent upon further development progress, solidifying proof-of-concept and additional progress towards eventual commercialization – whether organically or via licensing / partnering. It is also possible SNWV looks to just monetize the related IP – which also holds potential promise for revenue, or at least financing upside. To be clear, we think certain of these non-medical applications and expansion of the medical-related label may have real and, potentially significant value and we continue to remain encouraged by the recent development and validation progress – but we still feel it is too early to assign an estimated value – whether on a related-revenue or related-monetization basis.

Our modeled revenue also consists of OUS sales of ortho/dermaPACE. We think it is reasonable to assume that management's recent efforts to grow ex-U.S. sales via new distribution agreements and entry into new geographically territories can pay additional dividends in the form of a steepening of the overseas revenue curve. We have OUS sales (not including the MuniMed JV) growing from about $1.4M in 2016 to approximately $3.1M in 2019.

Our model now also contains forecasted contribution from the MundiMed JV, which incorporates the following assumptions;

- dermaPACE launches in Brazil in early 2019
- per-patient revenue is $725. Calculated as, 25% of estimated ($2,900) primary healing cost per-patient. Comprehensive study by Rezende, et al. calculated per-patient primary healing of DFU in Brazil cost $2,517 in 2008, equal to ~$2,900 today. We assume ~25% of that cost will be reimbursable for dermaPACE treatment
- Brazil DFU market size equals ~1M people
- 0.5% penetration (of only the DFU market) in the first year (2019) on the market
- 30% gross margin and operating expenses equal to approximately 30% of revenue
- We also include some fee-income as well as some device sales to the JV in 2018 and 2019 (i.e. the out-years in our model)

We have used P/S comp as our valuation methodology – for consistency, we continue to use that. Smith & Nephew has traded at approximately 3.5x analyst's 2019 forecasted revenue. With the updates to our model, we have SNWV generating approximately $11M (when including JV revenue – which on GAAP basis will be accounted for as a component in equity interest calculation) in revenue in 2019 - based on the SNN comp 2019 P/S multiple, this values SNWV at about $0.30/share.

FINANCIAL MODEL

SANUWAVE Health, Inc.

	2015 A	Q1A	Q2A	Q3A	Q4A	2016 A	Q1A	Q2A	Q3E	Q4E	2017 E	2018 E	2019 E
Total Revenues	$965.5	$269.3	$203.4	$255.7	$647.7	$1,376.1	$149.6	$111.0	$371.0	$648.0	$1,189.6	$4,325.0	$8,641.0
YOY Growth	*13.9%*	*28.0%*	*-15.2%*	*78.0%*	*74.3%*	*42.5%*	*-44.5%*	*-45.4%*	*45.1%*	*0.0%*	*-13.5%*	*263.6%*	*99.8%*
Cost of Revenues	$285.0	$73.2	$78.0	$98.7	$315.3	$565.1	$55.14	$24.7	$138.8	$275.5	$494.1	$1,247.4	$2,735.1
Gross Income	$680.5	$196.1	$125.4	$157.0	$332.4	$810.9	$94.4	$86.4	$232.2	$372.5	$695.5	$3,077.6	$5,905.9
Gross Margin	*70.5%*	*72.8%*	*61.7%*	*61.4%*	*51.3%*	*58.9%*	*63.1%*	*77.8%*	*62.6%*	*63.1%*	*58.5%*	*71.2%*	*68.3%*
R&D	$2,172.9	$310.0	$476.2	$266.5	$76.0	$1,128.6	$260.3	$437.9	$244.0	$297.0	$1,239.2	$1,854.0	$2,026.0
%R&D	*225.0%*	*115.1%*	*234.1%*	*104.2%*	*11.7%*	*82.0%*	*174.1%*	*394.4%*	*65.8%*	*45.8%*	*104.2%*	*42.9%*	*23.4%*
SG&A	$2,735.1	$499.1	$589.9	$645.9	$938.9	$2,673.8	$448.6	$951.9	$665.0	$692.0	$2,757.5	$3,996.3	$6,549.9
% G&A	*283.3%*	*185.3%*	*290.0%*	*252.6%*	*145.0%*	*194.3%*	*299.9%*	*857.2%*	*179.2%*	*106.8%*	*128.0%*	*92.4%*	*75.8%*
Depreciation	$3.6	$0.8	$0.8	$1.6	$16.6	$19.9	$6.1	$6.0	$6.0	$6.0	$24.1	$45.0	$75.0
Amortization	$306.7	$76.7	$76.7	$76.7	$76.7	$306.8	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Write down of assets	($100.0)	$0.0	$0.0	$0.0	($1.6)	($1.6)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Operating Income	($4,437.8)	($690.5)	($1,018.2)	($833.6)	($774.3)	($3,316.5)	($620.6)	($1,309.4)	($682.8)	($622.5)	($3,325.3)	($2,817.7)	($2,745.0)
Operating Margin	*-459.6%*	*-256.4%*	*-500.6%*	*-326.1%*	*-119.5%*	*-241.0%*	*-415.0%*	*-1179.2%*	*-184.0%*	*-96.1%*	*-279.5%*	*-65.1%*	*-31.8%*
Total Other Expense	($372.5)	($1,034.1)	($104.0)	($306.2)	($1,677.3)	($3,121.5)	$127.1	($106.5)	($313.0)	($355.0)	($647.4)	($1,275.0)	($1,300.0)
Pre-Tax Income	($4,810.2)	($1,724.6)	($1,122.1)	($1,139.8)	($2,451.5)	($6,438.0)	($493.5)	($1,415.9)	($995.8)	($977.5)	($3,972.7)	($4,092.7)	($4,045.0)
Taxes	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Tax Rate	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*
Net Income	($4,823.7)	($1,721.6)	($1,127.8)	($1,142.1)	($2,465.5)	($6,456.9)	($493.5)	($1,415.9)	($995.8)	($977.5)	($3,972.7)	($4,101.2)	($3,495.1)
YOY Growth	*-19.5%*	*46.9%*	*-25.9%*	*1.4%*	*145.9%*	*33.9%*	*-71.3%*	*25.5%*	*-12.8%*	*-60.4%*	*-38.5%*	*3.2%*	*-14.8%*
Net Margin	*-499.6%*	*-639.2%*	*-554.5%*	*-446.7%*	*-380.7%*	*-469.2%*	*-330.0%*	*-1275.1%*	*-268.4%*	*-150.8%*	*-333.9%*	*-94.8%*	*-40.4%*
EPS (continuing ops)	($0.08)	($0.02)	($0.01)	($0.01)	($0.02)	($0.06)	($0.00)	($0.01)	($0.01)	($0.01)	($0.03)	($0.02)	($0.02)
Diluted Shares O/S	63,025	75,220	102,646	115,529	137,084	107,620	138,042	138,993	141,000	162,000	145,009	190,000	215,000

Brian Marckx, CFA

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APPENDIX

De Novo Refresher

Pursuing De Novo U.S. Regulatory Pathway, Filing Made July 2016, Responded to Questions Jan 2017 …
On the Q1 '16 call in May 2016 management noted that, following their meeting with FDA, that they were in the process of putting together a PMA filing and at that time were anticipating the submission would be made in June or July. Clearly SNWV decided to consider alternative options and, apparently after additional consultation with MCRA, abandoned the PMA route in favor of the de novo pathway. On August 11th 2016 they announced that they submitted a de novo filing to FDA (on July 23rd) requesting that dermaPACE be classified as a Class II device. SNWV had noted previously that they were expecting a response from the agency in Q4 2016 but on the Q3 call (on November 10th) mentioned that they expected to hear back from FDA in January 2017 – also noting that they expected FDA's response would be in the form of additional questions.

On the Q4 '16 earnings call in early April 2017 management mentioned that their most recent interaction with the U.S. regulatory agency was in late-January/early-February of this year and consisted of responding to questions and clarifications related to the filing, clinical trial data and "technical performance and labeling."

So while management did not provide specifics of the questions or other inquiries from FDA, we interpreted their April 2017 message to be that the process continues to move along with no particular surprises. Management did specifically mention that they have been promptly replying to all of FDA's inquiries and that they (i.e. SNWV) expects a final decision from the agency later this year.

Our Comments:

De Novo primer: FDA created the de novo pathway in an effort to help streamline approval of novel, low-to-moderate risk medical devices. Prior to de novo the only route for new devices and for which there was not an acceptable predicate, regardless of their risk profile, was the relatively long, arduous and costly PMA process. In other words, novel, low risk devices were, by default, considered Class III, or high risk, medical devices if a similar device had not already been approved by FDA (i.e. lack of predicate excluded 510(k) route).

The 510(k) de novo pathway was created as part of the FDA Modernization Act of 1997 which was meant to streamline the review and approval process for novel, low-risk devices but was so cumbersome (and nonsensically requires the petitioner to first file a 510(k) then for FDA to respond with a 'Not Substantially Equivalent" (i.e. no predicate) letter before it can be refiled as a straight de novo) and time consuming that it was hardly ever used.

The FDA Safety and Innovation Act of 2012 brought a significant change by creating the direct de novo pathway which does not require an initial 510(k) filing. Instead an applicant can directly apply for their device to be considered a Class I or Class II device (with general or general and special controls).

Why SNWV's pivot from PMA to de novo? FDA has some discretion in the criteria and information that they use and how they apply that in determining whether a particular device should be cleared for sale. While this creates some ambiguity in terms of their decision-making process, there is no question that an acceptable benefit-risk profile is of paramount importance. The following document sheds some light on how FDA applies the risk-benefit tradeoff for the PMA pathway and for the de novo pathway.

Per FDA's, "Guidance for Industry and Food and Drug Administration Staff - Factors to Consider When Making Benefit-Risk Determinations in Medical Device Premarket Approvals and De Novo Classifications",

> *FDA determines whether PMA applications provide a "reasonable assurance of safety and effectiveness" by "weighing any probable benefit to health from the use of the device against any probable risk of injury or illness from such use," among other relevant factors. To aid in this process, PMA applicants submit valid scientific evidence, including one or more clinical investigations where appropriate, which FDA reviews to determine whether "the device will have the effect it purports or is represented to have under the conditions of use prescribed, recommended, or suggested in the labeling of the device." FDA staff review the data submitted as part of the PMA application and determine – based on a number of factors – if the data support the claims made by the sponsor concerning clinically significant results from the device, i.e., intended use and indications for use, and if the data analysis demonstrates that the probable benefits of the device outweigh its probable risks.*

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A balanced consideration of probable benefits and probable risks is an essential part of FDA's determination that there are reasonable assurances of safety and effectiveness.

Regarding the de novo pathway it goes on to say,

Because devices classified under this pathway (de novo devices) are low to moderate risk devices, they may not need to confer as substantial a benefit to patients in order to have a favorable benefit-risk profile. Devices granted marketing authority under de novo petitions should be sufficiently understood to explain all the risks and benefits of the device such that all risks can be appropriately mitigated through the application of general and/or special controls to provide reasonable assurance of safety and effectiveness.

If the primary endpoint (statistically superior difference in 100% wound closure at 12 weeks) had been met using the combined (pivotal plus supplemental clinical trials) study data, SNWV would have filed a PMA application. But the primary endpoint was not met. While the clinical data shows an efficacy signal, including significance on 100% wound closure at 20 weeks and, with certain sub-groups (such as high BMI patients), at 12 weeks, we think SNWV concluded (based on advice from MCRA, and potentially from feedback from FDA) that the benefit (i.e. efficacy), as interpreted by FDA under the PMA pathway, was not strong enough to support PMA approval. Or at least, not strong enough for approval without first going through a panel review – a process which would be drawn out and which could still result in a not approvable response.

By pursuing the de novo pathway, SNWV shifts more of the emphasis to the strong safety profile of dermaPACE, essentially lowering the approval hurdle given that, per FDA's guidance above, Class II devices "may not need to confer as substantial a benefit to patients in order to have a favorable benefit-risk profile".

As a reminder safety has been a non-issue. There was not a statistically significant difference in safety between the dermaPACE and control arms in the pivotal or supplemental study or when the data was combined with Bayesian analysis. In the combined data, 73.2% of dermaPACE subjects reported adverse events compared to the control's 68.9% (p=0.338). 55.8% of subjects saw treatment-emergent adverse events versus the control's 51.2% (p=0.444). Differences were not statistically significant.

We think the de novo pathway makes sense given dermaPACE's strong safety profile and the fact that FDA had previously communicated to SNWV that they will consider the totality of the efficacy data. As we have outlined in our discussion of the combined studies' results, there is an obvious efficacy signal. Another point in dermaPACE's favor, which relates to safety and lack of adverse events, is the non-invasive nature of the device – which would provide an alternative to other relatively invasive DFU therapies including negative pressure and skin substitutes.

Other considerations of de novo pathway:

- Review Time: For PMA's FDA's stated goal is to review and make an approval decision within 180 days. For direct de novo applications their stated goal is to make a determination within 120 days. In reality, however, FDA's turnaround time for both pathways is typically much longer than their cited respective timeline goals. PMA applications over the last few years have, on average, taken 15 – 18 months for the FDA to make a decision. And while one of the potential benefits that FDA has cited for the creation of the de novo pathway was reduced review and approval times, according to a study[1] by Hogan Lovells U.S. LLP, average review time for de novo applications in 2014 and 2015 was almost 400 days – while better than average PMA review time, this suggests SNWV may not hear a final decision until late Summer 2017 or later.

- Competitive considerations: assuming dermaPACE is cleared for sale as a Class II device, it potentially opens the door for competitors to cite it as a predicate device under a 501(k) clearance pathway. However, in reality it may not be that straightforward given the proprietary nature of SNWV's technology, the relative robustness of the randomized clinical trial design and supporting clinical data (notwithstanding the missed primary endpoint) and the special controls (required for a Class II submission) which may provide enough differentiation to thwart any competitors' attempts to claim "substantial equivalence" to dermaPACE. In addition, if SNWV were to successfully expand the label (for example to include other types of chronic wounds), precedent has suggested that FDA may disallow the 510(k) pathway for any competitors (that

[1] http://www.meddeviceonline.com/doc/the-de-novo-classification-process-a-work-in-progress-0001

were successful in citing dermaPACE as a predicate for chronic DFU) seeking the same indication to follow de novo.

- Wasn't an option until 2012: SNWV's pivotal dermaPACE study commenced in 2007 and the third and final module of the PMA filing was made in July 2011. The direct de novo pathway was not an option until July 2012. It's possible that SNWV would have initially chosen the direct de novo route had it been available.

- Switching from PMA to de novo: given the uniqueness of the situation, we do not know if the late-hour switch from PMA to de novo presents the potential for any distinct administrative or regulatory issues with FDA. We assume, however, that MCRA has already addressed anything that may relate to this and has enough comfort of the viability of switching to the de novo pathway

- Lower regulatory burden, cost: the de novo route may provide some relief to the regulatory burden as compared to PMA. While panel review was a real possibility with PMA, there is less likelihood that FDA will convene a panel with de novo. De novo submissions do not require the applicant to pay a user fee and typically will not require post-marketing studies (although the latter can be on a case-by-case basis). And, perhaps, most significant as it relates to regulatory burden is that if SNWV seeks in the future to expand the dermaPACE label, de novo clearance is much more streamlined than if PMA was pursued

Trial Data Refresher

U.S. dermaPACE Update: Combined data hit 100% closure @ 20, 24 weeks but supplemental trial missed on these measures. Promising sub-group and secondary data…

Additional supplemental clinical study and combined data (i.e. when the pivotal and supplemental data were combined using FDA-agreed Bayesian analysis) were announced in March 2016. As a reminder, 100% wound closure at the 12-week follow-up was the primary endpoint in both the pivotal and supplemental studies. Both studies failed to meet this. A subsequent meeting with FDA revealed that the agency was open to considering the totality of the data to support an efficacy claim in a future regulatory filing. As the pivotal study had shown statistical significance of 100% wound closure at 20 weeks, SNWV analyzed the combined data using that timepoint, as well as at 24 weeks, as a proxy for the primary endpoint.

In October 2015 the company announced that while the supplemental study did not hit statistical significance of 100% wound closure at 20 weeks, the combined data did. We noted that that was a highly promising development as had the combined data not shown statistically superior efficacy of dermaPACE over sham at the 20-week mark, that it was our opinion that the device would have had little to no chance of eventually gaining FDA approval/clearance. And, importantly, safety has not been an issue in either of the studies or when the studies were analyzed together.

On March 24th SNWV announced additional clinical data, through 24 weeks, related to both 100% wound closure as well as secondary endpoints and other potentially relevant results. Particular points of interest in the most recent announcement include;

100% wound closure:

- on combined analysis (i.e. data from both studies analyzed together) dermaPACE showed statistically significant superior efficacy over sham control in 100% wound closure at 24 weeks (in addition to the prior data which showed the same at 20 weeks)
    - 20 weeks: 35.5% dermaPACE vs. 24.4% control, p=0.027
    - 24 weeks: 37.8% dermaPACE vs. 26.2% control, p=0.023
    - In addition, management noted that there was a trend of superior efficacy of dermaPACE in wound closure beginning around week 14
    - 12 weeks: while more dermaPACE patients achieved 100% wound closure at 12 weeks as compared to sham control (22.7% vs. 18.3%), the difference was not statistically significant (p=0.32)
- supplemental study: dermaPACE was not statistically different than that of sham control in 100% wound closure at 20 weeks (p=0.339) or 24 weeks (35.4% vs 26.2%, p=0.254)

Secondary endpoints and other relevant analysis:

- Rate of healing: combined data showed approximately 25% of dermaPACE patients reached wound closure by week 12 (i.e. final follow-up of primary endpoint). The same percentage (25%) in the sham control group did not reach wound closure until day 112 (i.e. end of week 16)
    - combined data showed a statistically significant difference (p=0.0346) through 24 weeks favoring dermaPACE in the time to wound closure
- Wound area reduction: combined data showed statistically significant reduction in wound area favoring dermaPACE. The average wound area reduction in dermaPACE subjects was 1.92cm2 compared to 0.16cm2 in the control group at 24 weeks (p=0.047)
    - combined data showed a statistically significant difference in wound area reduction favoring dermaPACE from the week-six follow up through the end of the study
    - achievement of 50% wound area reduction also favored dermaPACE, although this just missed statistical significance at both 12 and 24 weeks
        - 66.9% of dermaPACE patients achieved at least a 50% decrease in wound size at 12 weeks compared to 60.4% in the control group (p=0.0554)
        - 70.4% of dermaPACE patients achieved at least a 50% decrease in wound size at 24 weeks compared to 61.6% in the control group (p=0.0899)
- Wound expansion: combined data showed statistically significant superior efficacy of dermaPACE compared to control in prevention of wound expansion. dermaPACE demonstrated superior results in the prevention of wound expansion (≥ 10% increase in wound size) over the course of the study at 12 weeks (18.0% versus 31.1%; p=0.005, respectively). While this trend continued through 24 weeks, the difference did not remain statistically significant
- Amputations: at 24 weeks, the limb amputation rate of the target ulcer was 2.3% for dermaPACE versus 3.0% in the control group. While the difference was not statistically different (p=0.745), the trend did favor dermaPACE and, given that amputations are relatively rare, the study would have needed to be much larger to demonstrate statistical difference in amputations
- Recurrence rates: combined data showed that at 24 weeks 92.3% of dermaPACE subjects who demonstrated wound closure did not have a recurrence of DFU versus 88.4% in the control group. Again, while not statistically different (p-value=0.490), the trend in recurrence rate did favor dermaPACE. But, perhaps more important is that this 92.3% non-recurrence rate (which is similar to the 95.5% non-recurrence rate of the pivotal dermaPACE study) compares very favorably to recurrence rates in clinical studies as high as 19% and 40% of Dermagraft and Apligraf, respectively. These are (relatively invasive and costly) skin substitutes used to treat DFU and potential competitors to dermaPACE.

Demographic sub-group analysis: a deeper dive was done to flesh out any differences-of-interest in results based on patient demographics. This could be relevant to design of potential follow-up studies

- **Height:** combined data showed statistically significant superior efficacy of dermaPACE compared to sham control (30.0% vs 14.1%) in 100% wound closure at 12 weeks with patients measuring 70 inches and taller
- **Age, BMI, height, sex:** while the combined data did show statistically superior efficacy of dermaPACE over sham control at 24 weeks, there were sub-populations in which efficacy of dermaPACE was even more pronounced. Patients younger than 65 years, body mass index (BMI) less than 32, height greater than or equal to 70 inches, and male subjects all had success rates statistically significantly higher than the control group (p = ≤ 0.050).

Safety remains a non-issue: there was not a statistically significant difference in safety between the dermaPACE and control arms in the pivotal or supplemental study or when the data was combined with Bayesian analysis. In the combined data, 73.2% of dermaPACE subjects reported adverse events compared to the control's 68.9% (p=0.338). 55.8% of subjects saw treatment-emergent adverse events versus the control's 51.2% (p=0.444). Differences were not statistically significant.

Assuming FDA does consider the totality of the data, there is reason to be hopeful that there is a pathway towards eventual U.S. marketing approval…

- while the supplemental study did not demonstrate an efficacy difference of dermaPACE versus sham control (i.e. standard of care) on the 100% wound closure measure for the entire trial population, it did show a statistically superior difference on this measure in those patients with a BMI of less than 32 (i.e. – less obese patients)

- the pivotal study as well as the combined data showed statistically superior efficacy of dermaPACE compared to sham control at both 20 and 24 weeks.
- combined data showed statistically significant superior efficacy of dermaPACE compared to sham control (30.0% vs 14.1%) in 100% wound closure at 12 weeks with patients measuring 70 inches and taller
- there were sub-populations in which efficacy of dermaPACE was even more pronounced at 24 weeks. Patients younger than 65 years, body mass index (BMI) less than 32, height greater than or equal to 70 inches, and male subjects all had success rates statistically significantly higher than the control group ($p = \leq 0.050$).
- there was also statistically significant differences or at least trends favoring dermaPACE over control in rates of healing, wound area reduction, prevention of wound expansion, amputations and recurrence rates. Recurrence rates of both dermaPACE studies also compare favorably to clinical studies of Dermagraft and Apligraf
- safety has consistently been a non-issue with dermaPACE. All other leading DFU therapies (skin substitutes, gels and VAC) are more invasive and susceptible to greater safety risks. As FDA must weigh risk and reward when considering approval of a novel therapy, dermaPACE's relatively low risk profile could work to lower its respective efficacy hurdle. By pursuing the de novo pathway, SNWV shifts more of the emphasis to the strong safety profile of dermaPACE, essentially lowering the approval hurdle given that, per FDA's guidance, Class II devices "may not need to confer as substantial a benefit to patients in order to have a favorable benefit-risk profile"
- one-size may not have to fit all with FDA. While 100% wound closure at 12 weeks has been the recent historical standard by which FDA has judged efficacy of DFU therapies, the fact that the agency continues to entertain the possibility of a pathway of approval for dermaPACE may mean they are open to other considerations. Given the strong safety profile of dermaPACE and less invasive nature as compared to other DFU therapies, coupled with efficacy signals in wound area reduction, rate of healing and lower recurrence, we think the de novo pathway makes sense.

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