K964425

APPENDIX H

JUL 28 1997

SUMMARY OF SAFETY AND EFFECTIVENESS

The A-V Impulse System Model 6060 (AVIS 6060) is designed to stimulate the natural pumping action of a patient's venous plexus system located in the sole of the foot. During the normal weightbearing phase of ambulation, blood is forcibly emptied from a plexus of veins in the sole of the foot into the deep and high pressure veins of the calf and thigh. This internal pump propels the blood up the leg and back to the heart. The AVIS 6060 foot pump mimics this natural physiological process for patients who are confined to the bed or are otherwise unable to walk normally due to trauma, surgery or pathology.

A similar pumping mechanism exists within the palm of the hand. There is a system of looping veins located near the metacarpo-phalangeal joints of the hand. Flexion of these joints triggers an internal pumping process that propels the blood into the deep and/or superficial veins of the arm and back to the heart. Besides flexing the fingers, increasing the tissue tension on the dorsum of the hand can trigger this pumping action. Either way, activation of the internal pump is followed by post-compression hyperaemia during which the venous plexus refills with blood.

A. Safety

The AVIS 6060 is a non-invasive medical device that applies brief pressure pulses to the palm of the hand or sole of the foot. Rather than altering or manipulating normal body functions, the AVIS 6060 seeks to mimic the natural pumping mechanisms that already exist in the venous plexus systems in the foot and hand. Accordingly, the AVIS 6060 is intrinsically safe. Apart from the intrinsic safety of the physiological mechanism of the AVIS 6060, the product's components are designed to minimize potential risks to patients during product use. In particular, the product is equipped with the following safety features:

- In the event of power failure or malfunction of the AVIS 6060 generator, the venting valve automatically opens so that any pressure in the ImPad is released.

- Audio and visual alarms are activated if ImPad pressure either exceeds or fails to achieve recommended levels. In the event of excess pressure, the unit automatically shuts down and can only be reactivated after the malfunction has been rectified and the unit reset. This feature protects the patient from potential problems relating to excess limb pressure. If the pressure is too low, the alarm sounds but the device continues to operate because this situation poses no threat to patient safety. The alarm merely

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signals to the operator that the product will not perform at normal effectiveness.

- Relevant contraindications are printed in the product's instruction manual and brochure.

- Numerous warnings concerning proper use and maintenance of the AVIS 6060 are contained in the instruction manual, advertising brochure, and various labels affixed to the product. For example, users are advised to pay special attention to patients with poor circulation and fragile skin, and to use additional padding according to clinical judgment. A warning that the product is not explosion proof and must not be used in the presence of flammable anesthetics or other gases is also included.

- The product's labeling indicates that the device is restricted to sale by or on the order of a physician.

- Software validation and other safety features.

In addition, the product has been independently tested for compliance with voluntary standards UL544–Standard for Medical and Dental Equipment (1994) and for compliance with electromagnetic compatibility standards. The AVIS 6060 successfully passed both tests.

B. Effectiveness

Set forth below is a brief summary of the clinical literature that supports the effectiveness of the AVIS 6060 for each of the clarified or new indications that Novamedix seeks to include in its labeling. In some cases, there are studies that directly support the proposed indication. For other claims, the support is more general in nature and based on established principles of medicine. Both kinds of support are described below. For convenience, the summaries are divided into two categories: lower extremity and upper extremity. A list of relevant clinical studies is included thereafter.

Lower Extremities

- ***Compartment Syndrome:*** Clinical investigators have reported in the medical literature that the AVIS 6060 products reduce dangerously high compartment pressures. Gardner et al. studied the effects of the AVIS products on swelling and compartment pressures in eleven patients with tibial fractures. Of these eleven patients, the authors concluded that impulse pumping prevented the need for surgical intervention in four patients. MacEachern et al. documented a case study in which treatment

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with the AVIS 6060 prevented the need for fasciotomy to relieve Compartment Syndrome. Other clinicians have also reported that the AVIS system is effective in reducing compartmental pressures.

- ***Edema Secondary to Trauma and/or Surgical Procedures:*** Gardner et al. found a statistically significant decrease in limb swelling (edema) in thirty eight patients following surgery or trauma to the lower extremity. In addition, Stranks et al. found that the AVIS 6060 provides a reduction in swelling in post-trauma patients undergoing hemiarthorplasty for displaced subcapital fractures of the femur. Myerson & Henderson also found that patients treated with the AVIS system, after trauma and surgery to the ankle, had a statistically significant reduction in swelling as compared to a control group. In a prospective study of forty patients, Stockle et al. found that impulse compression with the AVIS 6060 system resulted in significantly greater swelling reduction with respect to both post-traumatic (pre-operative) and post-operative treatment. Further, Beuker & Johnson found that treatment with the AVIS 6060 reduced swelling post-operatively following surgery for anterior cruciate ligament reconstruction, total hip arthroplasty and total knee arthroplasty. The England & Simms study of twenty patients found the use of the AVIS 6060 to decrease swelling in treated limbs post-operatively.

- ***Post-Bypass Graft Edema:*** Following arterial revascularization grafting for the lower extremity, England and Simms found a significant decrease in swelling in limbs of patients treated with the AVIS 6060. Similarly, White and Zarge reported that the AVIS 6060 significantly diminished post-operative edema in patients following lower extremity revascularization procedures and resulted in a lower incidence of wound complications.

- ***Post-Operative Edema Secondary to Venous Ligation or Venous Stripping:*** There is support for the conclusion that the AVIS 6060 is well-suited for use in patients with post-operative edema and diminished venous capacity secondary to venous ligation or stripping. Immediate ambulation on post-operative day one is recommended after these procedures although this is not always possible. The AVIS 6060 mimics ambulation that triggers the pumping action for the same natural circulatory response that is associated with walking. The AVIS 6060 has also been shown to significantly increase venous blood flow in the lower extremity and has been effective with patients with diminished venous capacity.

- ***Edema Secondary to Sprains, Strains and Sports Related Injuries:*** The AVIS 6060 has been shown to reduce edema following limb trauma in multiple studies, including studies that incorporated hip injuries, knee

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injuries, ruptured ligaments, ankle sprains, subtalar dislocations and dislocations of the ankle and foot. The device has also be found to provide significant reductions in post-traumatic edema in studies that included ankle fractures, calcaneal fractures, displace subcapital fractures of the neck and the femur, os calcis fractures, metatarsal fractures and tibial fractures.

- ***Pulmonary Embolism; Pre-, Intra- and Post-operative Prophylaxis for DVT and PE:*** Treatment with AVIS 6060 reduced the rate of fatal pulmonary embolisms (PE) from 9.1% to 0% and the six-month mortality from 18.2% to 6.3% in a randomized, prospective study involving ninety-two patients following surgical repair of hip fractures. In another randomized prospective study involving seventy-four patients undergoing total hip replacement, no PEs occurred in the group treated with the AVIS 6060 in comparison to a six PEs occurring in the control group. Other studies show that the AVIS 6060 reduces the incidence of proximal DVTs which are often precursors of PE.

  The Avis 6060 triggers the physiologic foot pump that is triggered during ambulation; as a result, the AVIS 6060 is ideal for patients who cannot ambulate before, during or after surgical procedures. The AVIS product has been used successfully pre-operatively, intra-operatively and post-operatively in the treatment of DVT and PE.

- ***Ischemia Secondary to Peripheral Vascular Disease:*** Gardner & Fox report on a controlled trial involving twelve patients with ischemic rest pain secondary to arterial disease in which all pumped patients had significant relief. Delis et al. found that the AVIS 6060 successfully increased exercise tolerance in patients with stable claudication, which is a form of ischemia secondary to peripheral vascular disease. Consistent with these results, Nicolaides & Delis have reported that the AVIS 6060 increases popliteal artery flow by 40-50% in patients with intermittent claudication secondary to PVD. A study of ten patients with stable intermittent claudication revealed that three months of therapy with the AVIS 6060 resulted in 70% increases in waking distances. Further, Morgan et al. found that treatment with the AVIS 6060 relieved ischemic rest pain significantly in a study involving ten patients with PVD. Morgan concluded from this test and from a study involving twenty-two patients that "in ischemic limbs [impulse pumping] can increase blood flow and relieve rest pain and so is likely to limit tissue damage in patients awaiting surgery or when surgery has nothing to offer".

- ***Raynaud's Syndrome:*** Raynaud's Syndrome is characterized by episodic attacks of vasospasm that cause diminished arterial blood flow secondary to

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closure of the small arteries and arterioles of distal parts of the extremities. It is established that the AVIS 6060 increases arterial flow, especially in patients with diminished arterial flow. The use of the AVIS 6060 results in the increase of blood flow in the affected extremities much the same way that medications used to treat patients with Raynaud's Syndrome treat the disorder.

- ***Range of Motion and Limb Mobility:*** In a study of twenty-three patients with os calcis fractures, Erdmann et al. found significant improvements in patients treated with the AVIS 6060 during the post-operative period. The authors found significant improvements in the pumped group in subtalar range of movement at three months, as well as an earlier return to work. Beuker & Johnson, in their study of patients undergoing anterior cruciate ligament reconstruction, total knee arthroplasty and hip arthroplasty, concluded that the AVIS treatment resulted in significantly less swelling and, as a result, faster attainment of motion goals.

- ***Reflex Sympathetic Dystrophy:*** Gardner & Fox presented four case studies involving patients with RSD. Each of these cases suggested that use of the AVIS 6060 reduced swelling and facilitated physiotherapy which helped to decrease some of the characteristics of RSD. RSD is characterized by pain, atrophic skin changes, hyperaemia, venous congestion, osteoporosis, and later relative ischaemia.

- ***Varicose Veins:*** The vast majority of treatment regimens for varicose veins involve treatments that increase venous return. McMullin et al. found that the AVIS 6060 increased venous return in patients with venous insufficiency. In addition, McMullin et al. noted that venous hypertension, which correlates will with the symptoms of varicose veins, occurs if either the muscle pump or the venous valves are incompetent. In the McMullin study, the AVIS 6060 was found to be effective in all types of venous insufficiency including deep, superficial and perforator incompetence. In a study conducted by Beuker & Johnson, the AVIS 6060 has been used successfully to treat varicose veins.

- ***Lymphedema Secondary to Trauma and/or Surgery and Post-Paralytic Lymphedema:*** The AVIS 6060 treats lymphedema by increasing venous return. Lymph flow is known to increase as venous flow increases. Thus, because treatment with the AVIS 6060 significantly increases venous flow, the AVIS can be expected to remove excess lymphatic fluid from the limbs. Gardner & Fox found the AVIS 6060 effective in reducing accumulations of lymphedema in patients following femora-popliteal bypass

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grafting. Impulse compression reduced the post-operative swelling in these cases.

Upper Extremities

- ***Compartment Syndrome:*** The objective in treating Compartment Syndrome is to remove and/or prevent the accumulation of fluid in the limb compartment to lower compartmental pressure. The AVIS 6060 has been found generally to reduce compartmental pressure levels which may allow a patient to avoid surgical intervention through fasciotomy. Additionally, the AVIS 6060 has been found in the upper extremities to reduce both post-trauma edema and consequent venous congestion which are the elements of the cascading events that lead to potential nerve and tissue damage and Compartmental Syndrome.

- ***Edema Secondary to Trauma and/or Surgical Procedures:*** Investigators have reported that post-traumatic swelling secondary to arm injuries can be reduced by impulse pumping. For example, in three case reports involving patients with post-traumatic swelling of the upper extremity associated with Reflex Sympathetic Dystrophy, swelling was reduced dramatically by impulse compression therapy. Twenty patients were successfully treated with the AVIS 6060 using a Hand ImPad. Significant reduction of swelling occurred within the first twenty-four hours in over fifty percent of the patients.

  Additional clinical investigators have found that the AVIS 6060 reduces post-traumatic and post-surgical edema. Significant decreases in post-traumatic edema occurred following seven to ten days of treatment with the AVIS 6060 with a Hand ImPad in two patients with radius fractures. The AVIS 6060 also was used to treat post-traumatic injuries to the hand and arm, resulting in dramatic reductions in swelling. The AVIS 6060 was also used on ninety patients to treat soft tissue injury to the upper and lower extremities. The use of the hand pad impulse system resulted in an average 52% reduction in swelling in four patients.

- ***Edema Secondary to Sprains, Strains and Sports Related Injuries:*** The AVIS 6060 is effective in reducing post-traumatic edema in the upper extremities, including edema associated with injuries with concomitant strains and/or sprains. The AVIS products also have been found to reduce compartmental pressures which can result in localized Compartment Syndrome such as frozen shoulder, supraspinatus tendinitis, tennis elbow and other tendon problems.

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- ***Ischemia Secondary to Peripheral Vascular Disease:*** Ischemia secondary to peripheral vascular disease ("PVD") results from decreased perfusion through the arteries supplying the extremities. The AVIS 6060 products increase arterial blood flow in the upper extremities by impulse pumping on the hand. In addition, the use of the AVIS in the upper extremity to treat PVD is further supported by the experiences using AVIS 6060 to treat PVD in the lower extremity.

- ***Raynaud's Syndrome:*** There is clinical support for using the AVIS products on patients with Raynaud's Syndrome. The AVIS 6060 increases arterial blood flow in the upper extremities for patients with Raynaud's Syndrome, which is consistent with the use of a number of medications commonly used to "increase blood flow." Patients with Raynaud's Syndrome who have considerably decreased blood flow in their hands and fingers can benefit from the AVIS products's ability to increase arterial blood flow.

- ***Range of Motion and Limb Mobility:*** For the same underlying reasons that AVIS is effective in improving range of motion, limb mobility and return of function in the lower extremity, AVIS is useful for these purposes in the upper extremity where the physiological effects of treatment with AVIS are identical. Use of the AVIS products also result in improved range of motion in patients with injury or trauma to the upper extremities. For example, Stockle reports that the range of motion was improved in patients treated with AVIS following radius fractures. The significant reduction in swelling and edema secondary to treatment with AVIS 6060 in the upper extremities result in faster attainment of motion goals. Kohrs found that post-trauma use of the AVIS in the upper extremity resulted in an average 52% reduction in swelling and that the AVIS 6060 facilitated early use of the extremity.

- ***Reflex Sympathetic Dystrophy:*** There are a number of case reports involving the use of the AVIS 6060 to treat patients with Reflex Sympathetic Dystrophy. For example, Gardner & Fox present four case studies involving injuries to hands, each case suggesting that the product is useful to reduce swelling and facilitate physiotherapy. Additionally, Liedke has reported success in treating reflex sympathetic dystrophy in the upper extremity, and Stockle has reported similar clinical success using the alternative term "algodystrophy."

- ***Lymphedema Secondary to Trauma and/or Surgery, Post-Mastectomy Lymphedema, and Post-Paralytic Lymphedema:*** The AVIS 6060 treats lymphedema by increasing venous return. Lymph flow is known to

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increase when venous flow increases. The AVIS 6060 removes excess lymphatic fluid from the upper extremities by increasing venous flow in the arms.

AVIS 6060 has also been found to reduce lymphedema in patients following temoro-poplitcal bypass grafting, and because the underlying physiological effects of the AVIS system is identical in the upper and lower extremities, the ability of AVIS to treat lymphedema in the upper extremity can be explained similarly.

Relevant Clinical Literature

Abu-Owen, "Effects of Intermittent Pneumatic Compression of the Foot on the Microcirculatory Function in Arterial Disease", European Journal of Vascular Surgery, (1993).

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Clinical Practice of Sports Injury Prevention and Care, Renstrom, P.A.F.H. et al., Editors, Blackwell Scientific Publications, London, England.

Coffman, J.D., Cohen, A.S., "Total and Capillary Fingertip Blood Flow in Raynaud's Phenomenon," New England Journal of Medicine, 285:259 (1971).

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DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Food and Drug Administration
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Rockville MD 20856

Novamedix Services Limited
C/O Mr. William H.E. von Oehsen
Powell, Goldstein, Frazer & Murphy
1001 Pennsylvania Avenue, N.W.
Sixth Floor
Washington, D.C. 20004

JUL 28 1997

Re: K964425
A-V Impulse System Model 6060 Expanded Indications for Foot and Hand
Regulatory Class: II (Two)
Product Code: 74 (JOW)
Dated: April 28, 1997
Received: April 29, 1997

Dear Mr. von Oehsen:

We have reviewed your Section 510(k) notification of intent to market the device referenced above and we have determined the device is substantially equivalent (for the indications for use stated in the enclosure) to devices marketed in interstate commerce prior to May 28, 1976, the enactment date of the Medical Device Amendments, or to devices that have been reclassified in accordance with the provisions of the Federal Food, Drug, and Cosmetic Act (Act). You may, therefore, market the device, subject to the general controls provisions of the Act. The general controls provisions of the Act include requirements for annual registration, listing of devices, good manufacturing practice, labeling, and prohibitions against misbranding and adulteration.

If your device is classified (see above) into either class II (Special Controls) or class III (Premarket Approval), it may be subject to such additional controls. Existing major regulations affecting your device can be found in the Code of Federal Regulations, Title 21, Parts 800 to 895. A substantially equivalent determination assumes compliance with the Current Good Manufacturing Practice requirement, as set forth in the Quality System Regulation (QS) for Medical Devices: General regulation (21 CFR Part 820) and that, through periodic QS inspections, the Food and Drug Administration (FDA) will verify such assumptions. Failure to comply with the GMP regulation may result in regulatory action. In addition, FDA may publish further announcements concerning your device in the Federal Register. Please note: this response to your premarket notification submission does not affect any obligation you might have under sections 531 through 542 of the Act for devices under the Electronic Product Radiation Control provisions, or other Federal laws or regulations.

This letter will allow you to begin marketing your device as described in your 510(k) premarket notification. The FDA finding of substantial equivalence of your device to a legally marketed predicate device results in a classification for your device and thus, permits your device to proceed to the market.

If you desire specific advice for your device on our labeling regulation (21 CFR Part 801 and additionally 809.10 for in vitro diagnostic devices), please contact the Office of Compliance at (301) 594-4648. Additionally, for questions on the promotion and advertising of your device, please contact the Office of Compliance at (301) 594-4639. Also, please note the regulation entitled, "Misbranding by reference to premarket notification" (21 CFR 807.97). Other general information on your responsibilities under the Act may be obtained from the Division of Small Manufacturers Assistance at its toll-free number (800) 638-2041 or (301) 443-6597 or at its internet address "http://www.fda.gov/cdrh/dsmamain.html."

Sincerely yours,

Thomas J. Callahan

Thomas J. Callahan, Ph.D.
Director
Division of Cardiovascular, Respiratory,
and Neurological Devices
Office of Device Evaluation
Center for Devices and
Radiological Health

Enclosure

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510(k) Number (if known): K964425/S1

Device Name: A-V Impulse System Model 6160

Indications For Use:

Comparison of Indications for Lower Extremity	
Approved Indication	Proposed Clarification or Expansion
Acute edema	Reduces acute edema, such as elevated compartment pressures, edema secondary to trauma and/or surgical procedures, post-bypass graft edema, post-operative edema secondary to venous ligation or venous stripping and edema secondary to sprains, strains and sports related injuries of the lower extremity.
Chronic edema	Reduces chronic edema.
Deep vein thrombosis prophylaxis	Assists in treating patients at risk for deep vein thrombosis (DVT) and pulmonary embolism (PE), including providing pre-, intra, and post-operative prophylaxis for DVT and PE.
Circulation enhancement	Relieves circulatory disorders secondary to diminished blood flow, such as ischemia secondary to peripheral vascular disease.
Leg ulcers	Assists healing of cutaneous ulcers.
Leg pain incident to trauma or surgery	Relieves pain, increases range of motion and limb mobility, and expedites return of function following trauma or surgery.
[redacted]us stasis/venous insufficiency	Treats venous stasis, venous insufficiency and varicose veins.
	Reduces lymphedema, including lymphedema secondary to trauma and/or surgery and reduces or controls chronic lymphedema, including post-paralytic lymphedema due to stroke or spinal cord injury.

Comparison of Indications for Upper Extremity	
Approved Indication	Proposed Clarification or Expansion
Acute edema	Reduces acute edema, such as elevated compartment pressures, edema secondary to trauma and/or surgical procedures, and edema secondary to sprains, strains and other sports related injuries of the upper extremity.
Chronic edema	Reduces chronic edema.
Circulation enhancement	Relieves circulatory disorders secondary to diminished blood flow, such as ischemia secondary to peripheral vascular disease.
Pain	Relieves pain, increases range of motion and limb mobility, and expedites return of function following trauma or surgery.
	Reduces lymphedema, including lymphedema secondary to trauma and/or surgery, post-mastectomy lymphedema, and reduces or controls chronic lymphedema including post-paralytic lymphedema due to stroke or spinal cord injury.

(PLEASE DO NOT WRITE BELOW THIS LINE - CONTINUE ON ANOTHER PAGE IF NEEDED)

Concurrence of CDRH, Office of Device Evaluation (ODE)

(Division Sign-Off)
Division of Cardiovascular, Respiratory, and Neurological Devices

510(k) Number

Prescription Use ✓ (Per 21 CFR 801.109) OR Over-The-Counter Use

(Optional Format 1-2-96)

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