Telemedicine-cloud: Perinatal Services in Rural Areas

Introduction:

America has the highest maternal mortality rate among the industrialized countries. A gradual increase in the maternal mortality rate was observed from 12/100,000 births in 1990 to 28/100,000 births.[1] This alarming statistical data has been mentioned in both the print and electronic media (The Washington Post, New York Times, USA Today, Wall Street Journal, NBC, CBS, and National Public Radio). A new paradigm for the postpartum care in America was proposed by the American College of Obstetricians and Gynecologists.[2] Several publications mentioned that the quality and quantity of maternal care declined in rural America.[3-8] In 2015 pregnancy-related complications caused 64% more deaths among rural area pregnant people than people in urban area.[9] Recently attempts were made to improve the rural health care[10] especially the rural hospitals and the reimbursement system.[11]

Following the guidelines of the American College of Obstetrics and Gynecology and the U.S. Preventive Services Task Force, all the pregnant women shall be screened for depression. Further counselling shall be available via telemedicine by a board certified psychiatrist.

We have solved the problem of providing perinatal care in rural areas of America. The quality of care is comparable to an urban hospital and the obstetrician does not need to travel to the pregnant people.

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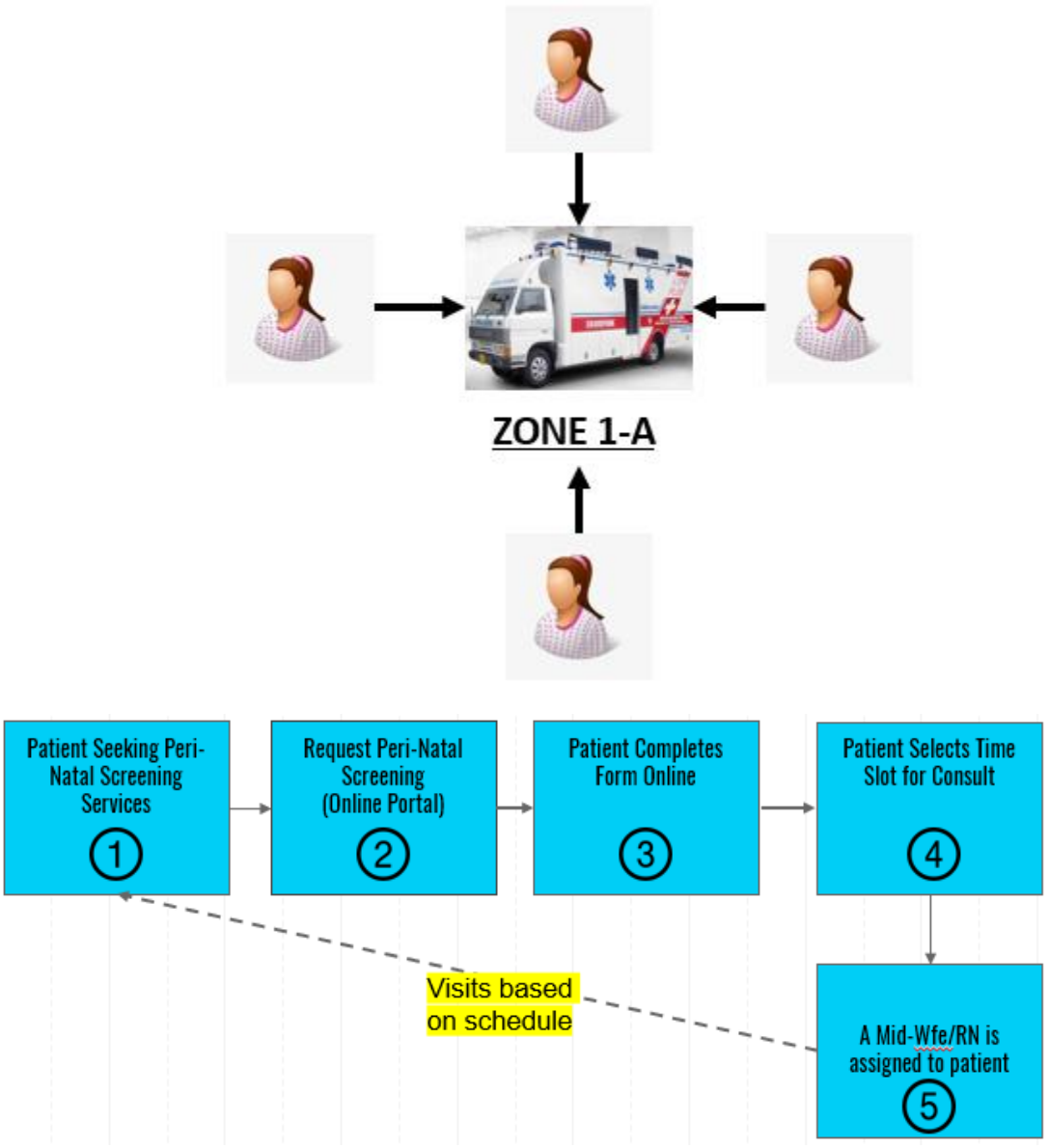
The Solution:

Fortutec developed a solution that integrates portable devices and Telemedicine platform. The telemedicine platform includes the video conference via Zoom and also viewing the medical imaging via Dicom viewer. The caregiver carries the portable devices in the telemedicine van and record the readings in the system which are in turn sent to Electronic Medical Record. The medical-telemedicine van is equipped with computers, servers, telecommunication modules, and the state-of-the-art testing equipment, e.g., ultrasound, EKG, Spirometer, Colposcope, biomedical analyzers, etc.

How it works:

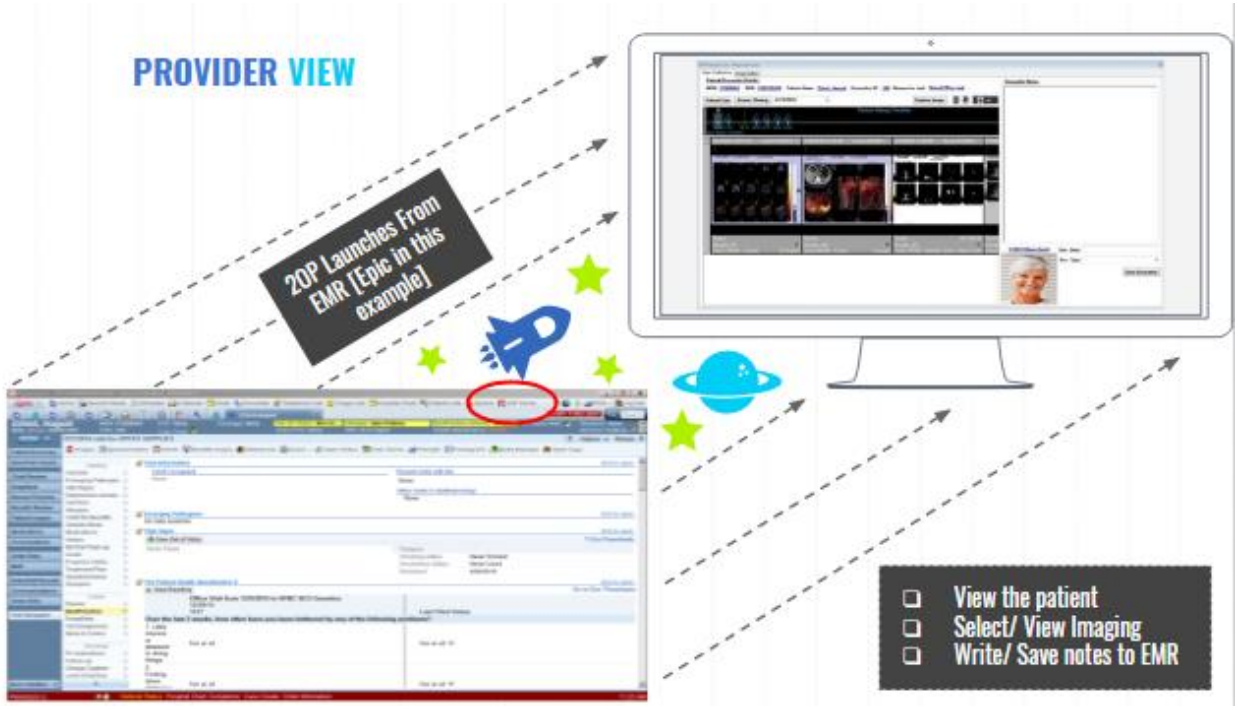


Technology:

This web based solution is developed using C#, open source Dicom, Zoom for video integration.

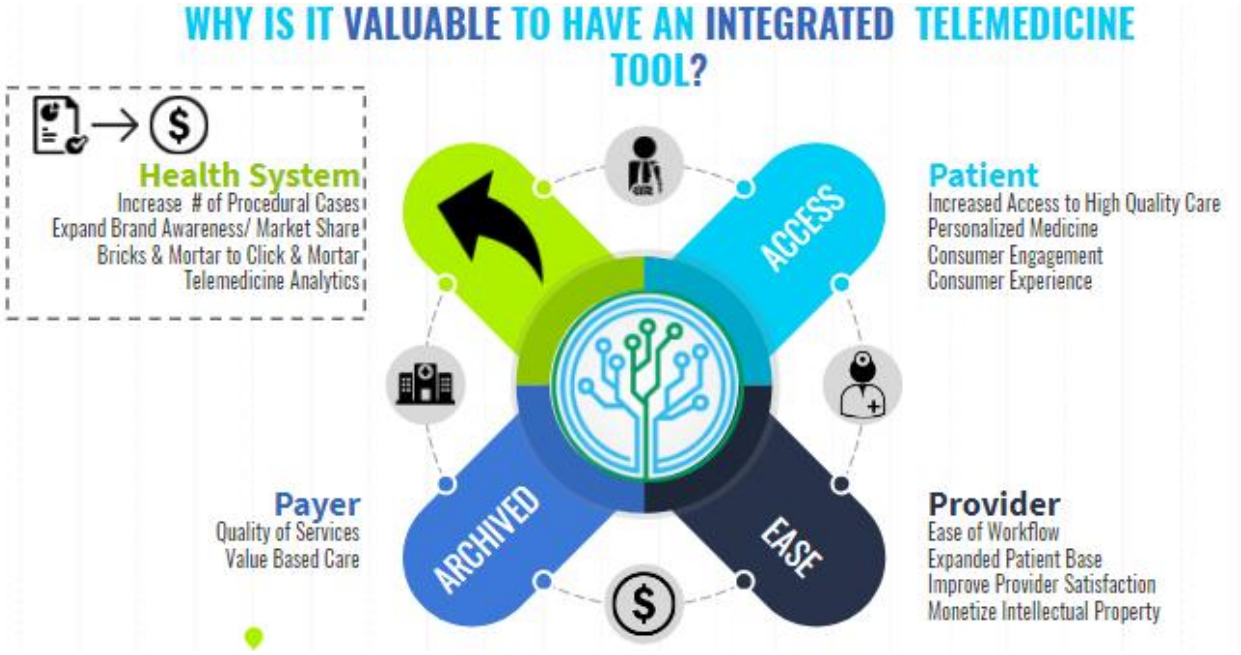
The pregnant patient launches the online portal and request for a peri-natal screening. A schedule and a care plan are then created for the patient based on the Telemed-Zone which is assigned based on her zip/postal code. The Telemedicine-Van follows its

schedule and visits a central location of the zone. The patient drives to the location of the van and the Mid-Wife or Registered Nurse takes care of the rest of the process. Of collecting the vitals and readings using the portable devices and record them in the system. The results are then sent to EMR. If the Mid-wife/Nurse has a question, they can have a conversation via telemedicine platform with Physician and get the questions/concerns/issues addressed. If needed, the patient is asked to visit hospital.



Value proposition of the solution:

1.) Very helpful to pregnant women living in rural areas
2.) At home service and can avoid stressful journey to clinics
3.) Physicians time is effectively used
4.) Cost savings to Health care system



Competition:

No competition in the market at this time.

Appendix I. Perinatal Care in the State of Michigan

In a survey (1999-2010) the State of Michigan pregnancy-related mortality[1] rate per 100,000 live births was 22.2 (overall 8th highest in America) as compared to the national average of 15.6. The national pregnancy related mortality rate[2] was comparable to Michigan's rate in 2011 (17.8 and 17.5 per 100,000 respectively). However, pregnancy-related deaths in Michigan are starting to decrease[3], reaching a low of 8.9 deaths per 100,000 live births in 2012.

Both the infant mortality rates (2017) by cause of death for the State of Michigan (Table 1), and during the maternal health/prematurity period cause of death, State of Michigan (Table 2) indicated that perinatal conditions are predominantly responsible as compared to other causes[4].

Table 1. Infant mortality rates (2017) by cause of death for the State of Michigan

	Frequency	State	Reference	Excess Rate
Congenital Anomaly	137	1.23	1.16	0.07
Other	51	0.46	0.37	0.09

Perinatal Conditions	**169**	**1.52**	**1.17**	**0.34**
Sleep-related	99	0.89	0.44	0.45
Infection	14	0.13	0.04	0.09
Injury	50	0.45	0.21	0.24
Total	520	4.66	3.38	1.29

The “Frequency” is defined as the total number of deaths in a particular category. The “State” is defined as the number of deaths in Michigan due to a specific cause divided by the number of live births. The “Reference” group is white non-Hispanic women, over 20 years age and less than 40 years old, with at least 13 years of education or are intending to use private insurance at delivery. The excess rate is calculated by subtracting the “Reference” value from the “State” value. Infant death >20 weeks of gestation and >500 grams birth weight.

Inference: In the target group, the cause-specific mortality rate for perinatal conditions (1.52 per 1000 live births) is higher than that of the other identical causes.

Table 2. Infant mortality during the Maternal Health/Prematurity Period by Cause of Death, Michigan 2017

	Frequency	State	Reference	Excess Rate
Congenital Anomaly	30	0.27	0.25	0.02
Other	16	0.14	0.07	0.07
Perinatal Conditions	**124**	**1.11**	**0.82**	**0.29**
Sleep-related	2	0.02	0.00	0.02
Infection	2	0.02	0.00	0.02
Injury	2	0.02	0.00	0.02
Total	175	1.58	1.14	0.44

The “Frequency” is defined as the total number of deaths in a particular category. The “State” is defined as the number of deaths in Michigan due to a specific cause divided by the number of live births. The “Reference” group is white non-Hispanic women, over 20 years age and less than 40 years old, with at least 13 years of education or are intending to use private insurance at delivery. The excess rate is

calculated by subtracting the “Reference” value from the “State” value. Infant death >20 weeks of gestation and >500 grams birth weight.

Inference: During the maternal health and prematurity period, the cause specific mortality rate for perinatal conditions in the target group is 0.29 per 1000 live births higher than the reference group.

A recent average infant mortality rate by county, Michigan (2012-2016) indicated[5] 9.7 per 1000 live births in eleven (11) counties (Branch, Genesee, Gladwin, Ingham, Lenawee, Mecosta, Muskegon, Oceana, Saginaw, Wayne and Wexford); and >9.7 per 1000 births in five(5) counties (Arenac, Crawford, Gogebic, Kalkaska, and Presque Isle). All these five counties with infant mortality rate >9.7 per 1000 births are rural areas of Michigan.

A recent study[6] was done to determine the cost savings to Medicaid from the Maternal Infant Health Program (MIHP) due to reduction in preterm birth rate. It was found that for every $1 spent on prenatal services for MIHP participant mothers, Medicaid saved $1.38 in costs associated with preterm birth in the first month of life. This kind of “Return on Investment” suggests the significance of “Perinatal Care in Michigan.”
We have divided the State of Michigan (Fig. 1) into three (3) zones (A, B and C) for the implementation of “Telemedicine-cloud: Perinatal Care in the State of Michigan.”

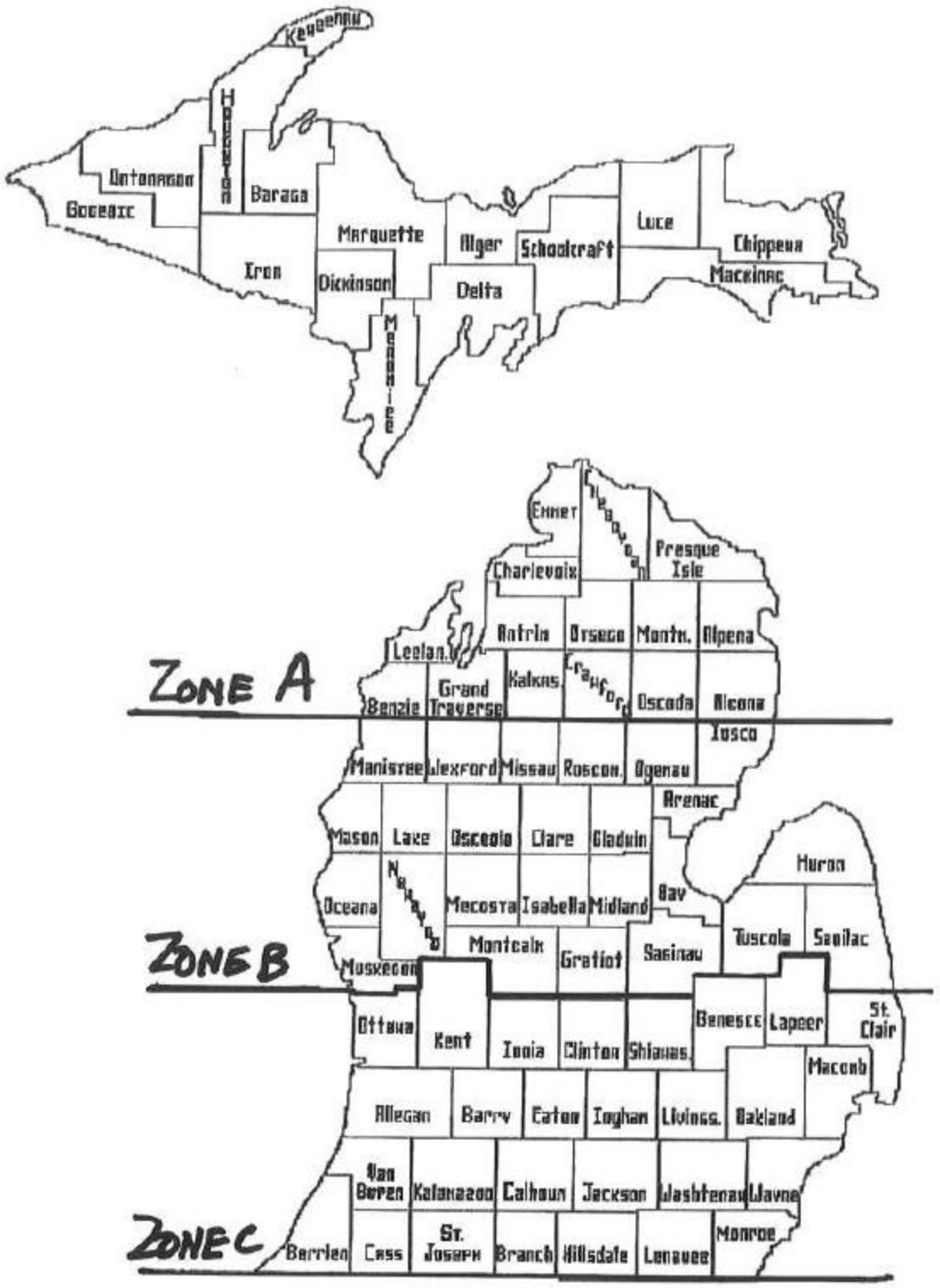


Table 3. Zone “A”, Michigan Counties Data 2017

Name	Total Population	Female (18-39) Population	Live Births

Alcona	10351	772	58
Alger	9121	742	63
Alpena	28462	3131	290
Antrim	23292	2294	161
Baraga	8441	763	69
Benzie	17573	1870	159
Charlevoix	26139	2767	217
Cheboygan	25369	2525	229
Chippewa	37711	4676	324
Crawford	13907	1413	138
Delta	35965	3855	345
Dickenson	25415	2840	247
Gogebic	15342	1452	128
Grand Traverse	91807	11899	921
Houghton	36305	5187	372
Iron	11124	989	95
Kalkaska	17634	3036	180
Keweenaw	2105	157	13
Leelanau	21657	2067	175
Luce	6358	527	60
Mackinac	10712	997	41
Manistee	24427	2242	210
Marquette	66502	10656	587
Menominee	23046	2347	179
Montmorency	9250	789	68
Ontonagon	5881	389	31
Oscoda	24538	2970	255
Presque Isle	12791	1112	101
Schoolcraft	8049	757	71

Table 4. Zone “B”, Michigan Counties Data 2017

Name	Total Population	Female (18-39) Population	Live Births

Arenac	15045	1585	113
Bay	104239	13140	1011
Clare	30653	3318	331
Gladwin	25234	2438	245
Gratiot	41018	5189	385
Huron	31280	3222	314
Iosco	25162	2350	228
Isabella	71063	16699	681
Lake	12013	1110	123
Mason	29073	3216	301
Mecosta	43391	7092	414
Midland	83411	10892	871
Missaukee	14998	1709	191
Montcalm	63550	7717	721
Muskegon	173693	23270	2125
Newaygo	48242	5740	539
Oceana	26442	2994	263
Ogemaw	20981	2165	204
Osceola	23260	2696	268
Roscommon	23895	2045	163
Saginaw	191934	26079	2248
Sanilac	41269	4609	434
Tuscola	52764	6173	555
Wexford	33276	4038	374

Table 5. Zone C, Michigan Counties Data 2017

Name	Total Population	Female (18-39) Population	Live Births
Allegan	116447	14753	1348
Barry	60586	7227	635
Berrien	154259	19572	1728
Branch	43410	5060	530
Calhoun	134128	18325	1536
Cass	51381	5868	507
Clinton	78443	10365	824
Eaton	109027	14849	1131
Genesee	407385	55344	4713
Hillsdale	45879	5817	534
Ingham	290186	57619	3175
Ionia	64291	7721	713
Jackson	158640	20017	1770
Kalamazoo	262985	46102	3055
Kent	648594	103089	8684
Lapeer	88174	10117	788
Lenawee	98623	12281	980
Livingston	189651	22467	1808
Macomb	871375	119101	9252
Monroe	149649	18687	1504
Oakland	1250836	168130	13184
Ottawa	286383	45799	3253
St. Clair	159350	19034	1462
St. Joseph	60947	7566	747
Shiawassee	68446	8577	672
Van Buren	75353	9114	867
Washtenaw	367627	70552	3553
Wayne	1753616	255522	23257

Discussion

The selection of the three Zones (A, B and C) in the State of Michigan (Figure 1) was done arbitrarily without any consideration of the demographics of the state.

The "Zone A" has 29 counties and twenty seven of them consist of small towns, villages and farms. In view of the scattered population of the residents and absence of a nearby community hospital, the pregnant patients have to travel long distance for perinatal care. In some instances only the midwife takes care of the pregnant patient. Our logistical analysis suggests that two "Mobile Medical-Telemedicine" vans shall be required to serve the entire population of the pregnant patients in "Zone A."

The "Zone B" has 24 counties and eight counties are representative of industrial towns and large cities (average births 1093/year). These eight counties provide easy access to conventional perinatal care. Some of the pregnant patients living in the remaining 16 counties reside at the cusp of the community hospitals in these largely populated eight counties, and thus do not need perinatal care via telemedicine-cloud technology. We shall need only one "Mobile Medical-Telemedicine" van to provide perinatal care in the small town, villages and farms of the remaining 16 counties in "Zone B."

The "Zone C" consists of 28 counties and are densely populated than most counties of "Zone A and B." Major medical centers and hospitals are located in these counties and currently provide perinatal care to all the pregnant patients.

We are studying the financial aspects of telemedicine-cloud based perinatal care for both the rural and urban areas of the State of Michigan. We are waiting for the payments data to the physicians, hospitals/clinics, etc by the Medicaid and insurance companies. However a recent study by the State of Michigan indicated 158% return on investment on the perinatal care[6].

Summary

Telemedicine-cloud computing using Xoom and DICOM technology shall provide the quality of perinatal care to pregnant patients in small towns, villages and farms similar to that currently available in urban areas of America by conventional methods. The costs of medical care employing telemedicine-cloud technology shall be lesser than the currently prevailing medical care in America. The mortality and morbidity rates of the pregnant patients and the infants shall be lower in the State of Michigan by employing telemedicine-cloud technology than the national average as well as the western countries.

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