

# Healthcare Management, avoidable mortality, telemedicine to improve health of the diabetic population

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## Abstract

**Background:** Worldwide the International Diabetes Federation (IDF) estimated that in 2021 9.2% of adults (536.6 million, between 20 and 79 years of age) are diabetic and 32.6% under 60 years (6.7 million) die because of diabetes. This disease is set to become the leading cause of disability and mortality by 2030. In Italy, the prevalence of Diabetes is about 5%; in the pre-pandemic period, from 2010 to 2019, diabetes was responsible for 3% of deaths recorded, while during the pandemic in 2020, these deaths increased to about 4%.

The present work aimed to measure the outcomes obtained from the ICPs (integrated care pathways) implemented by a Health Local Authority according to the model of the Lazio region and its impact on avoidable mortality, i.e., those deaths potentially avoidable with primary prevention interventions, early diagnosis and targeted therapies, adequate hygienic conditions and proper health care.

**Materials and Methods:** Data from 1675 patients enrolled in the diagnostic treatment pathway were analyzed, 471 with type 1 diabetes and the remainder with type 2 (mean age 17.5 and 69, respectively). 987 patients with type 2 diabetes also had comorbidities: in 43% obesity, 56% dyslipidemia, 61% hypertension, 29% COPD. In 54% they had at least 2 comorbidities. All patients enrolled in the ICPs were equipped with a glucometer and an app capable of recording results on capillary blood, 269 with type 1 diabetes were equipped with continuous and 198 insulin pump measurement devices. All enrolled patients recorded at least one daily blood glucose reading, one weekly weight reading, and recorded steps taken daily. They also underwent glycated hemoglobin monitoring, periodic visits and scheduled instrumental checks. A total of 5500 parameters were measured for patients with type 2 diabetes and 2345 for patients with type 1 diabetes.

**Results:** Analysis of medical records revealed that 93% of patients with type 1 diabetes were found to be adherent to the treatment pathway, adherence of patients with type 2 diabetes was recorded in 87% of enrolled cases. The analysis of accesses to the Emergency Department for decompensated diabetes saw only 21% of patients enrolled in the ICPs, but recording poor compliance. The mortality in enrolled patients was 1.9% compared with 4.3 percent in patients not enrolled in ICPs, and patients amputated for diabetic

foot resulted in 82% of patients not enrolled in ICPs. Finally, it is noted that patients also enrolled in the telerehabilitation pathway or home care rehabilitation (28%), with the same conditions of severity of neuropathic and vasculopathic picture presented a reduction of 18% in leg or lower limb amputation compared to patients not enrolled or not adhering to ICPs, a reduction of 27% in metatarsal amputation and 34% in toes amputation.

**Conclusions:** Telemonitoring of diabetic patients allows for greater patient empowerment with increased adherence, as well as a reduction in Emergency Department and inpatient admissions, thus resulting in ICPs being a tool for both standardization of quality of care and standardization of the average cost of the chronic patient with diabetic disease. Likewise, telerehabilitation can reduce the incidence of amputations from diabetic foot disease if associated with adherence to the proposed pathway with ICPs.

## Background

Worldwide, the International Diabetes Federation (IDF) estimated that, in 2021, 536.6 million people between 20 and 79 years of age (9.2% of adults) are diabetic, a number that is set to increase to and 783 million in 2045.

In 2021, deaths attributable to diabetes globally between 20 and 79 years of age were 6.7 million, 32.6 percent of the total in people under 60 years of age (1).

In Italy, the prevalence of Diabetes is about 5%.

In the pre-pandemic period, analyzing the time frame from 2010 to 2019, diabetes was responsible for 3% of deaths recorded in Italy (3), while in 2020, during the pandemic, these deaths increased to about 4%. According to ISTAT data, diabetic disease is set to become the leading cause of disability and mortality by 2030 (2).

The guidelines of the Italian Diabetes Society (3) document that in order to reduce the morbidity, mortality, and premature disability that diabetes entails, as well as to limit the inequalities caused by social and economic conditions that affect health status, an approach that includes population strategies (health promotion programs) and strategies on the individual (early identification of those at risk and subsequent care) is needed. The organizational model for such an approach is represented by the Integrated Care Pathways (ICPs) which ensures a multidimensional and multiprofessional approach also with the support of telemedicine.

The present work aimed to measure the outcomes obtained from the ICPs implemented by a local health authority according to the model of the Lazio region and its impact on avoidable mortality, i.e., those deaths potentially avoidable with primary prevention interventions, early diagnosis and targeted therapies, adequate hygienic conditions and proper health care.

## Materials and Methods

Data from patients enrolled in the diagnostic treatment pathway were analyzed and 1675 patients were evaluated, 471 with type 1 diabetes and the remainder with type 2 diabetes. The average age of patients with type 1 diabetes was 17.5 years while for patients with type

2 diabetes the average age recorded was 69 years.

987 patients with type 2 diabetes also had comorbidities: in 43% obesity, 56% dyslipidemia, 61% hypertension, 29% COPD. In 54% they had at least 2 comorbidities.

All patients enrolled in the ICPs were equipped with a glucometer and an app capable of recording results on capillary blood. 269 patients enrolled in the ICPs diagnosed with type 1 diabetes were equipped with continuous and 198 insulin pump measurement devices.

All enrolled patients recorded at least one daily blood glucose reading, one weekly weight reading, and recorded steps taken daily.

They also underwent glycated hemoglobin monitoring, periodic visits and scheduled instrumental checks, see Table 1.

Bimonthly	Quarterly	Semiannual	Once a year
HBA1c	Fasting blood glucose on serum	General medical examination with BMI calculation and assessment of body weight and abdominal girth	Lipid profile
	Measuring blood pressure	Liver function tests	microalbuminuria
	Complete urinalysis	Full blood count	Glomerular filtrate or creatinine or creatinine clearance test
	BMI assessment		Fundus oculi
			ECG
			Annual foot and lower extremity examination
			Investigation for the possible presence of neuropathic symptoms

**Table 1.** Standards of intake

Patients also underwent echocolor Doppler of supraaortic vessels with the following schedule:

every 5 years (if normal or mid-intimal thickening);

every 2 years (if noncritical stenosis: <50%);

every year (if subcritical stenosis: 60-70%);

As well as at lower limb echocolor Doppler:

every 3 years;

or every year if complications.

Instead, all ICPs participants underwent an app interview once a month investigating adherence to diet, therapy, and lifestyle.

A total of 5500 parameters were measured for patients with type 2 diabetes and 2345 parameters for patients with type 1 diabetes.

## Results

Analysis of the detected 7845 parameters revealed 827 out-of-range parameters that resulted in intervention by telemonitoring operators and 123 interventions by the diabetes specialist for drug treatment modification. Three patients accessed the Emergency Department and 18 to an extraordinary outpatient visit.

Analysis of medical records revealed that 93% of patients with type 1 diabetes were found to be adherent to the treatment pathway, adherence of patients with type 2 diabetes was recorded in 87% of enrolled cases.

The analysis of accesses to the Emergency Department for decompensated diabetes saw only 21% of patients enrolled while the remaining patients who accessed the Emergency Department for decompensated diabetes were not found to be enrolled in the ICPs.

The analysis of emergency admissions for complications of diabetes mellitus revealed that 65% were never found to be enrolled in the ICPs and 21% had been enrolled but had recorded poor compliance.

There was a diabetes mellitus mortality of 1.9 percent in enrolled patients compared with 4.3 percent in patients not enrolled in ICPs.

Data analysis also highlights that patients seen in the outpatient clinic for urgent visit in 78% were never found to be enrolled in ICPs and in 19% were found to be non-adherent to the pathway.

Moreover, patients amputated for diabetic foot resulted in 82% of patients not enrolled in ICPs.

Finally, it is noted that patients also enrolled in the telerehabilitation pathway or home care rehabilitation (28%), with the same conditions of severity of neuropathic and vasculopathic picture presented -18% of the number of leg or lower limb amputation compared to patients not enrolled in ICPs or not adhering to ICPs and -27% of metatarsal amputation and -34% of toes amputation.

## Discussion

Mortality and morbidity data document that proper patient risk assessment at the time of ICPs enrollment and the patient's relative adherence to the proposed pathway and treatments reduces mortality and morbidity. In addition, telemonitoring of diabetic patients allows for greater patient empowerment with increased adherence to the pathway and treatments, as well as a reduction in Emergency Department and inpatient admissions, thus resulting in ICPs being a tool for both standardization of quality of care and standardization of the average cost of the chronic patient with diabetic disease. Likewise, telerehabilitation can reduce the incidence of amputations from diabetic foot disease if associated with adherence to the proposed pathway with ICPs.

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